things and get very excited, then inflate the usefulness of something, find we've inflated it, get resentful because we feel we've been taken, and then go looking for something else. Multimedia will have to go through that cycle to some extent."

Part of the reason for that cycle of experimentation, discovery, and reinvention is that multimedia is still too young to have been tested and conclusively proven effective in research labs. (See box, page 24, for more on research.) Even those using it for years, like D'Ignazio, agree that "there is no integrated, single approach and certainly not one that says, 'This is the way you use multimedia.' It's a market open to diverse and sometimes homegrown approaches," says D'Ignazio. "But that's what personal computers were for a long time."

Why It Seems to Work

Homegrown approaches in classrooms around the country have become the unofficial testing ground for multimedia—with positive results. Stories abound of ultra-motivated students and rejuvenated teachers working interactively, manipulating and creating projects, producing concrete examples of things they have learned.

According to Elliot Soloway, associate professor of electrical engineering and computer science, University of Michigan, Ann Arbor, in classrooms using multimedia, learning becomes an active process where the student uses the technology to communicate his understanding of a subject to those around him. Often, as a result, classroom structures change. Seats set in rows start to form clusters where teams can work. Teachers may adjust methods to become navigators, no longer feeding information to students for storage and regurgitation on tests. And students are expected to take information in, process it, and put back something of themselves that says yes, they understood what it was they've been exposed to.

"It's a constructive, not instructive process," says Soloway. "Kids can't just be presented with images. They must be able to create with images the things they are learning, because you actually learn by doing."

At the Ralph Bunche School, New York City, for example, sixth-grade students have used multimedia to create their own half-hour news show, Kid Witness News. Paul Reese, computer coordinator, says, "I use multimedia very little in the presentation mode because most of its value is in the kids doing it themselves."

Multimedia supports all the multiple intelligences not necessarily supported through a text-dominated environment.

– Fred D'Ignazio

Doing a news show, says Reese, students may use Grolier's Encyclopedia on CD-ROM to research topics, then use word processors to write and edit the script for the show. The videotaping is done by students with advisor supervision. Final editing requires some help from advisors, and then students view the completed production on a VCR. A simple multimedia project like this, says Reese, allows them to express their views through the topics they choose (one show featured a UNICEF meeting at the United Nations and an international track meet at Madison Square Garden) and the way they cover those topics.

One of multimedia's most touted charms is its ability to stimulate self-expression. Soloway—also director of the HiCE Research Group (Highly Interactive Computing Environments) at the university—says that the issue isn't at all whether or not multimedia is good for learning, but rather "how to let students use it to generate a sense of ownership, self-expression, participation, and communication. That's

COSTS

Multimedia Technologies: A Primer

Here's a listing of some technologies you might find in a multimedia classroom. The prices are estimates so you might find even lower prices. And, if you're really wondering where to begin, the simplest and most common use of multimedia today is a combination of a computer, videodisc player, and TV.

- **Computer**: Get a model that includes the CPU, keyboard, operating system, a color monitor (black and white's not recommended for multimedia) and a hard disk drive. $1,000 to $2,500. [High-end models cost more.]
- **Hard drive**: A necessity and, if not already included with the computer, costs $200–$500.
- **Mouse**: If the computer you bought doesn't have one, it's a necessity. $50.
- **Videodisc player**: Get a level one or level three. $800–$1,000.
- **Television**: Minimum 25-inch screen; great as a display with a VCR. $300 and up.
- **Printer**: Should have graphics capability and color ribbon; dot matrix printer works well, but you can also use an ink jet or laser printer, which may cost more. $400 to $1,000.
- **Scanner**: To input images from a flat source, such as a photograph, illustrations, or text use a hand-held or flatbed scanner. Prices vary.
- **Video camera**: Captures three-dimensional and moving images, which you can later scan into a computer using a video digitizer. $400 and up.
- **Video digitizer**: Transfers non-computer images (images from VCR, TV, videodisc, etc.) to computer form. $100 to $600.
- **Audio digitizer**: Transfers sound to computer form. $150 to $500.
- **Speakers**: Get speakers for the computer if they aren't already built in. Cheap.
- **CD-ROM drive**: $400 to $800. (Some computers need a SCSI card, about $200, to hookup the CD-ROM drive.)
- **VCR**: Great as a display device (instead of a projector) used with your TV. $200 and up.
- **Sound source**: A tape recorder or record player. $20 and up. (Don't forget the cables.)
- **Keyboard**: Add music to your life for $40 to $500. And with a $5 cable, can connect to headphones jack on VCR.
- **Telephone**: Because the multimedia station is, after all, a communicating station. $20 and up. You can also do a lot with just a phone jack and cable, $5.
- **Modem**: $75 to $250.

— Compiled with the help of Fred D'Ignazio, Multimedia Classrooms, Inc., East Lansing, MI

Photograph By Randy Edmonds

'Tiny tech' offers new learning modalities for students and teachers

By Fred D'Ignazio, Director
Teacher Explorer Center

My favorite *Calvin and Hobbes* strip is one that I pulled off the calendar in our kitchen at home. The strip shows Calvin as Spaceman Spiff, blasting around the galaxy, discovering a new dimension where time has no meaning. In most of the strip, Spiff is in control. He is heroic. He is making life or death decisions. However, in the last panel, Calvin is no longer the spectacular Spiff. He is just a kid sitting at his desk at school. "Off camera" we hear his teacher saying, "Now we carry the one into the tens column..."

When I was young I was a "Spaceman Spiff." Now I am the father of an eleven-year-old Spaceman Spiff. In fact, we are raising a whole generation of Spaceman Spiffs. Their egos and imaginations are fed a steady fantasy diet of MTV, one-second video and sound bites, Ninja Turtles, Wrestlemania, Stephen King, Nintendo, high-powered commercials, jazzed-up movies with computer-synthesized special effects and digital, high-fidelity surround sound.

It's a sea of electronic media out there. And our kids are submerged in the sea, with their eyes, ears, minds, hearts and imaginations wide open, swimming through the media, devouring the media, seeing themselves reflected in the media.

And then the school bell rings.

Our children scramble into school and leave the outside world behind. They close the classroom door and the turbulent sea of images, rotating text, voices, music and sounds disappears. The tide recedes. The sea dries up. And in its place is a tiny trickle of numbers and words — a *spoken* stream flowing from the mouth of the teacher and a *printed* stream slowly scanned on a page in a textbook.

How do kids react to being yanked from the sea, hauled from their habitat, beached like a whale on an arid shore?

Who you gonna call? Spaceman Spiff!

'Tiny tech' to the rescue

Clearly we have a problem here. Teachers have important things to teach their students — language skills, computational skills, science, history, culture, civilization. We can't have our students tripping out just when we serve up a carefully crafted meal selected from each of the basic educational food groups.

Fortunately, help is near. In the past ten years something new has come into the world — *tiny tech* — a blizzard of tiny, portable computers, video cameras, VCRs, cellular phones, fax machines, musical keyboards, walkmen and other miniature gadgets. We have mistaken most of these devices for toys, but they are really not toys at all. Instead they are multimedia pencils — harbingers of a new era in human history, an era of interactive, multi-sensory, restructured knowledge.

In past eras what were the carriers of knowledge? The human mind, the mouth, spoken language, written language. In the world of the past the power tools of knowledge were the pencil and pen.

Now new pencils and pens are emerging. Video cameras, for example, are visual and auditory pens, capable of capturing real-world images and sounds from a child's own world — the real stuff of life as kids live it.

(Reprinted with permission from **Michigan Technology Quarterly**, Summer 1990)

Fred D'Ignazio, Director of Michigan's 1st Teacher Explorer Center

New camcorders like Sony's TR5 weigh only a few ounces and fit into a kindergartner's hand. Camcorders will soon be small enough, simple enough, portable enough, cheap enough to become children's personal thinking tools and the carriers of what children feel, think and observe about the world around them.

Post-desktop fusion

There is something else out there, too. It's more than a sea of media. It's a process of rapid, accelerating confluence and convergence. All those tiny devices — the cameras, TVs, faxes, etc. — are coming together and fusing. They are becoming something beyond computers, beyond TV, beyond telephones, beyond copying machines and other familiar appliances that have become the mundane fixtures of the adult workplace.

We are witnessing *post-desktop fusion*. It is "fusion" because computers, cameras and other knowledge appliances are transforming themselves, combining functions and growing smaller and smaller. The process is so quick that we can almost see with the naked eye. It is "post-desktop" because we are swiftly moving beyond the desktop as a metaphor and as a hub for capturing, processing and communicating knowledge.

We used to talk about "desktop computing" to reflect the fact that computers were small enough to fit on everyone's desktop. But computers have continued to shrink to post-desktop sizes — from transportable to portable, from portable to laptop, from laptop to notebook. Now we have pocket computers. And talking *wrist-top computers* with built-in speech-recognition and cellular fax modems are not far away.

Dick Tracy, here we come!

The term "desktop computing" is also troublesome from the *computing* point of view. In a world in which microchips have burrowed their way into every appliance to make it "intelligent" and "programmable," where is the real computer? It may be the *video computer* that we use to capture images and sounds and that we call a "camcorder." Perhaps it is the "smart TV" or "programmable telephone" or the battery-powered, portable fax copier.

One thing is certain, computers are not just boxes resting on desktops. Instead they are more like caterpillars busily transforming into butterflies of startling shapes and sizes. And herein lies our opportunity for restructuring knowledge — to expand knowledge beyond a narrow stream of text and talk to a rich flood of multimedia knowledge that feeds the senses, stirs the imagination and pierces the heart. Learners are not just little, linear *text computers*. They are human beings with bodies, senses and sensitivities that yearn to be tapped. It is time that we feed and nurture human beings as whole persons and let them communicate in a multitude of modalities.

Teachers work together in cooperative — learning groups to create multi-media presentations.

Multimedia pencils — spaceage kids

Where are the fresh metaphors to inspire us and help us understand a world of interactive, multi-sensory, restructured knowledge?

Is the textbook an appropriate metaphor? The black board? The desktop?

Be honest. How appealing is the desktop for the average human being — adult or child? Do little images of trash cans and file folders really turn you on? Do they capture the power of creating interactive presentations that begin to have the "look and feel" of the real world?

Do they reflect the way "knowledge" will be captured, constructed and transformed in the workplace of the future? The "desktop" is appropriate if your pen is made of wood and lead and you need a flat, horizontal writing surface to become an author.

It is less appropriate if you can become an author with a little mobile *fusion pencil* that includes a stylus and a screen on which to write, that runs on batteries, that has a built-in video camera (or jack), a microphone, a cellular faxmodem and stereo speakers.

You can hang your "pencil" from your shoulder or pop it into your knapsack. You can take it to conduct multimedia interviews with senior citizens who actually lived through the Great Depression or the First World War, or scientists at a local college or business, or city officials who are struggling with where to locate a new prison, how to dispose of solid waste, or how to preserve the

habitat of an endangered animal.

You can "write" using your fusion pencil while you are at a friend's home, or on the playground, on a bus, at the kitchen table, or under a tree. In a world of fusion pencils the desktop is ***the world*** and your job as a young multimedia author is to go out and capture bits and pieces of that world to share, describe and make understandable to those around you.

Using a fusion pencil, all those Spaceman Spiffs out there can put "pen to paper" and create dazzling, animated graphics, moving images and high-fidelity sounds. They can create miniature models of the real world that come to life through the shrewd use of sounds, images and words that engage the imagination.

They can become authors in media they now only consume.

Teachers who recognize the power of these new multimedia pencils are smart. Their students can explore restructured knowledge and do multimedia publishing — in the classroom and on a shoestring.

For example, a savvy teacher can build a scavenged publishing center for her students out of the flotsam and jetsam of scuffed-up devices that kick around every school (the record players, tape players, VCRs, TVs, computers and cameras). A teacher can be on the cutting edge by repurposing low-cost equipment she already has and by combining it into a multimedia publishing center that simulates fusion pencils of the future.

These centers tap young people's vast, latent, hidden skills in an emerging world of restructured knowledge. Children have acquired enormous navigational "literacy" skills from a lifetime of swimming through a sea of electronic multimedia. Children already know how to "read" this media. Now let's teach them how to "write" it.

And not stop there.

What is knowledge?

If a teacher is going to help her students restructure knowledge she first must ask herself what is knowledge? If knowledge is *text* then students can use word processors, animation programs, CD-ROM and online data bases to capture knowledge, organize it and create publications.

If knowledge is *images*, then students can capture, explore, manage and manipulate knowledge with video cameras, laserdiscs, computer graphics, etc. If knowledge is *sounds* then students can capture sounds with microphones, digitize sounds into the computer and explore sounds on a tape player, a walkman or record player.

If knowledge is people's *spoken words*, then students can tape their words and the stirring words of famous individuals such as Thomas Edison, Martin Luther King, Jr. and Helen Keller.

If we redefine "knowledge" as being something more than spoken and written text, we move to a new definition of knowledge — not a post-Gutenberg definition but a *Gutenberg Plus* definition of knowledge. The Gutenberg Plus definition retains the high regard for written and spoken language, for language as a tool of thought, communication and imagination.

But it also values young people's significant skills in visual literacy, auditory literacy, in manipulating complex visual, textual, auditory and three-dimensional models (computer games) and young people's experimental attitude toward mastering and troubleshooting complex multimedia equipment.

A smart teacher should value these skills and assign responsibilities to students to help guide them and harness their skills to produce restructured knowledge *demonstrations* and *knowledge experiments* that would be too rich and too multi-faceted for the teacher to attempt on her own.

A smart teacher can work with students to create multimedia databases and interactive presentations.

A smart teacher should not feel inadequate if students' technical skills far exceed her own. She should not feel intimated if students' work surpasses her work. But she should avoid multimedia ***productions*** like the plague.

"Production" is a word from the past — from the era of Hollywood, Madison Avenue and Broadway. It is a term describing **one-way media** that is produced by producers and consumed by everyone else. A production is linear, often passive and incapable of being altered, annotated or repurposed by the user. A production makes me the producer and everyone else the audience. Productions themselves can be pits. They are costly, time-consuming and require special expertise.

Productions are not practical for daily classroom learning. They are also not appropriate for the coming era of personal, interactive, restructured knowledge.

What is appropriate? How about knowledge experiments, "how-to" demonstrations, rapid prototypes, instant publishing and throwaway multimedia databases. Students' multimedia research and publishing must be cheap, quick, dirty and out the door to meet students' and teachers' needs. It must be conversational — students and teachers must feel free to invent, experiment, draft, test and reshape the media on the fly.

Classroom publishing centers should not be little TV studios and publishing houses. These are models of the old media. Instead they should be messy innovation labs, inquiry centers and impromptu spaceships that take students and teachers on low-budget, half-hour *electronic field trips* to explore knowledge spatially and contextually — just as it exists in the real world.

Classrooms of tomorrow

A classroom in the future will have the look and feel of

the real world. With the addition of low-cost telecommunication devices (fax modems, two-way cable TV, etc.) students in physical classrooms will be able to collaborate and form virtual classrooms that span cities, states and countries. Students will be able to participate in virtual "share-a-student," "junior-year abroad," and "foreign-exchange" programs electronically rather than physically. Teachers will help students reach out to scientists, policymakers, business leaders, writers and artists and invite them into the classroom as virtual guests, virtual teachers and virtual "writers in residence" for a day, a week or a semester.

In the classroom of the future students will be able to assemble multimedia databases on their computers that have a startling, lifelike quality. The databases will have fragments of the real world — its sounds, its voices, its music, its images, its spoken and written languages — its exceedingly rich profoundly important *texture*. The proof of the success of the databases will be how well they mimic and recreate reality and, equally, how well they help student authors and their classmates explain, describe and understand the real world.

When they are successful, multimedia databases can become something more than "databases." Perhaps we need a new term to describe them. Perhaps "knowledge bases," "meaning bases," or "reality bases" is more apt.

Or how about *virtual reality*?

In the classroom of the future, students will move away from memorization of facts and become authors skilled at crafting *models of the real world*. These little virtual-reality databases will have the look and feel of the real world, but they will be computer-based simulations that can be paused, replayed and analyzed from a dozen different perspectives — including mathematical, spatial, historical, geographical, contextual, etc.

You might call them multimedia *story problems* in which students focus on the dilemmas of real people — moms, dads, scientists, explorers and quarry foremen — as they confront life and try to make timely decisions despite too little information, too little time and a chaos of competing distractions and alternatives.

These story problems can become the interactive presentations that students create for their classmates and challenge their classmates to solve with the aid of the multimedia databases for research, experimentation, "what-if" speculation and "just-in-time training."

(The Michigan Department of Education has awarded a grant to East Lansing Public Schools to set up a model "classroom of tomorrow" that demonstrates the ideas above. The name of the classroom is the Teacher Explorer Center.

The center will host demonstrations and free, full-day workshops for teachers, policymakers and community leaders through September.

This Month

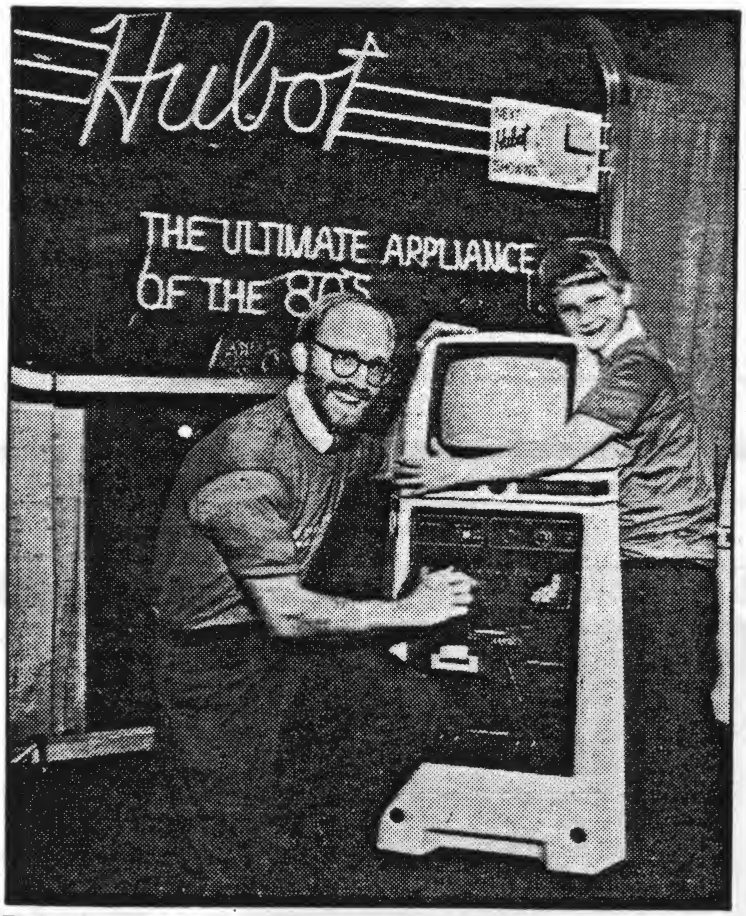
3 *Roanoke computer wizard Fred D'Ignazio talks about musical keyboards on THE NEW TECH TIMES March 3 and 10 at 6 p.m.*

3/10/85

WORTH A LOOK

Roanoker Fred D'Ignazio

"New Tech Times"
Ch. 15, 6 p.m.
This week's show is noteworthy because a Roanoker, computer writer and robot enthusiast Fred D'Ignazio, will be featured in a segment taped at the Muppet Mansion in New York.



Robotics expert Fred D'Ignazio and 12-year-old Rawson Stovall will decide who gets to adopt 'Hubot.'

Help around the house just around the corner

Longing for a little company around the house? Adopt-A-Robot, a promotional gimmick from *The New Tech Times*, may be the answer. The award-winning public television series will give away a $3,500 robot called "Hubot" to the viewer who says best in 100 words or less how he or she would make the 115-pound machine feel at home.

Within Hubot's 44-inch body is a 64K personal computer,

Entertainment Tomorrow

by Allen L. Wold and Fred D'Ignazio

LIGHT SABERS AND LASERS

A few weeks ago one of us (Allen) attended a science fiction convention in Virginia Beach. While doing some after-hours browsing through the huckster's room, he saw a new role-playing game for sale, called *Killer*. It is a set of rules for real-life role playing, in which the players assume the roles of assassins, who try to kill each other using harmless weapons such as water pistols and rubber hand grenades. A number of convention attendees who had purchased it were playing it in the halls when not attending panels and movies.

We have been to other conventions where some form of real-life *Dungeons and Dragons* was attempted. Someone hides a treasure somewhere in the hotel (the hotel employees really love this), and the players spend hours tracking it down, with simulated combats whenever appropriate.

In *Killer*, however, there is no dungeon master. Instead, two to about a dozen players decide in advance what the limits and objectives of the game will be: from a one-on-one assassination attempt to be concluded by a specific time in one day, to a week-long campaign involving several people. The game does not require constant attention: It can be incorporated into and be worked around a day's regular activities.

Whatever one may think about the violence content of the game, those who were playing seemed to be enjoying themselves. Not a gang fight but a test of tracking and ambushing skills, it is more like training for a career as a process server delivering summonses, than as a warrior.

Though our knowledge of the game is slight, we can still see that it is a sign of some kind. Role-playing games are coming off the mapboard and out of the notebook, and getting into the real world. The point is that people want to participate more than the "traditional" role-playing games allow, to assume the role of their hero in a broader context. A psychology text could be written on the desire of people to live out fantasy adventures in the flesh. We're not going to do that.

Instead, we are going to take it as a given that people **do** want to assume the role of a hero in more than just a paper and pencil game. They want to feel the tension and excitement of a real hunt for treasure or an enemy, but at the same time they do not want it to be real. They do not want to kill, cheat, or otherwise dominate people in real life. They only want to have the satisfaction of having done so in a "real world" fantasy.

The two facets of a role-playing game are equally important: role-playing, and game. Without the game aspect, there are no heroes, just psychotics. Critics of *D&D* and other similar games should bear this in mind.

The fantasy aspect allows players to experience a form of behavior in which they would not indulge in real life. Few people really want to enter a dank dungeon with monsters in it, no matter how much treasure there might be. The fantasy is a way of confronting certain fears and problems safely, without the danger inherent in a real-life situation.

Given that people want more direct experience, and at the same time the security of knowing that it's all fictitious, there is a lot that can be done.

Killer is not computerized, so we will not deal further with it. But there are two ways a computer can assist in achieving a direct but fictitious adventure experience, though not without other technology.

One is for the computer to provide the entire environment, assisted by wrap-around video, stereo sound, and other sensory input, such as described by John D. MacDonald in his classic story, *Spectator Sport*, which appeared first in *Thrilling Wonder Stories*, February, 1950, and has since been included in many anthologies.

It concerns a time traveler to the future. He is assumed by the authorities to be insane, and "cured." This has the unfortunate effect of destroying his mind. When the authorities discover that he really is a time traveler from the past, they try to make up for their mistake by giving him a free life-time admission to one of the dream machines, which everybody else in that time saves for all their lives to buy into.

One is placed in the machine; eyes, ears, voice, hands, and feet are connected to electronic sensing devices; and the machine presents adventures for the person to experience: from harems to old west, from soap opera to space opera. Read the story, and see one idea of the ultimate "Computer Assisted Role-Playing Game." We will be discussing this aspect of fantasy gaming at a later time.

Another way the computer can assist in achieving an adventure experience is for the computer, in some of its various incarnations, to assist in real-time playing. That is, instead of the players entering the machine, the machines are attached to the players. Which brings us to the subject of this column: exploring two facets of one way such a thing might be done.

The idea for this column came when we were discussing some of the ways computers can assist in our recreation. Suddenly a light flashed, almost literally, in Allen's mind, and he said, "computerized fencing."

There already is electric fencing. The combatants wear special jackets embedded with a light metal mesh and hooked by long wires to boxes, one for each fencer. Their foils have spring-loaded buttons at the tip, and are also connected, by another wire, to their boxes.

When the tip of the foil is depressed, it closes a circuit. If the foil is touching the floor, or some part of the opponent not covered by the mesh jacket, a red light goes on, indicating a foul. If it is depressed while in contact with the opponent's jacket, a different circuit is closed, and a green light goes on, indicating a fair hit. This reduces the number of judges necessary at a fencing match from five to one. It also removes any doubt as to whether the touch was actually made. A light graze won't depress the button. A hit on the opponent's sleeve flashes red.

Suppose, instead of a metal foil, a very weak laser were used (such as those in grocery store check-out registers), focused at a point where the tip of the foil would be. The opponent's jacket would be photoelectrically sensitive to laser light of a cer-

tain intensity, and the focus would be strong enough to signal a fair hit.

So far so good, but no computers used , and no score if you ran your opponent through — the light nearer the guard, being out of focus, would also be too faint to register.

The next logical step is the laser pistol, again using a beam of light too faint to cause any harm. The opponents would wear a mask which would completely filter out the color of the laser light, and so protect the eyes from any chance of damage. Otherwise, the laser would hurt no more than a flashlight.

Or you could have fast-draw gunfights, a la old west. Each pistol would be a laser (with sound effects if you wish), and when the fighters draw and fire, the laser beam would strike whatever it is aimed at. The players' clothes would be sensitive to the laser light, and record who hit whom where and when.

There are two ideas here: one is fencing, the other is gunfighting. Let's see where fencing takes us.

There is a toy on the market called *Boffers*, foam broadswords which allow two combatants to hit each other as hard as they like without any damage whatsoever.

You can fence with a foil, because it is flexible and has a button point, even though it is made of steel. But try fencing with a four-pound broadsword, and even with dull edges and padding, people are going to get hurt. The Japanese use bamboo swords for their fencing, which are light and flexible, but they can still give an awful whack and require lots of padding if you're not going to get bruised. So *Boffers* are the perfect solution, though they don't have the heft or weight of a real sword.

The Society for Creative Anachronism fences with real swords (blunted) and in armor. But not everybody has access to the SCA, nor has the time the SCA demands of its members to fully develop and learn the skills necessary before they are allowed to fight. Again, the *Boffers* are a solution. But let's take them a step further.

Suppose the lightweight plastic sword were loaded with strain gauges. When you strike an opponent, the gauges tell how hard you hit. Calibrated to a real sword, the gauges would tell you whether you just nicked the fellow, or cut him through. When the two swords hit each other, both record a hit, but contact between the two negates the score. Only contact on the opponent's armor (perhaps lightweight Mylar with circuitry embedded as in electric fencing) would allow the computer-controlled gauges to score a real hit.

You could do the same with battle axes, morning starts, maces, or any medieval weapon. Wired to boxes controlled by a computer, you could fight away to your heart's content without any fear of damage. Only contacts on the opponent would count. The weapons would transfer to the boxes the amount of force applied, the location of the hit, and so on, and disabling hits would be signalled and recorded. No more shouting: "I hit you first." "No, you hit my shield." "I did not. I hit your shoulder."

The computer would know, by the nature of the circuit closed, just who hit whom where and how hard, and keep track of all hits. As players developed, their "constitutions" would improve, and they would be able to take more hits: *D&D* combat in the flesh, with all the character promotions included. You assume a role, the parameters are entered into the scorekeeping computer, and you fight with the handicap of your character.

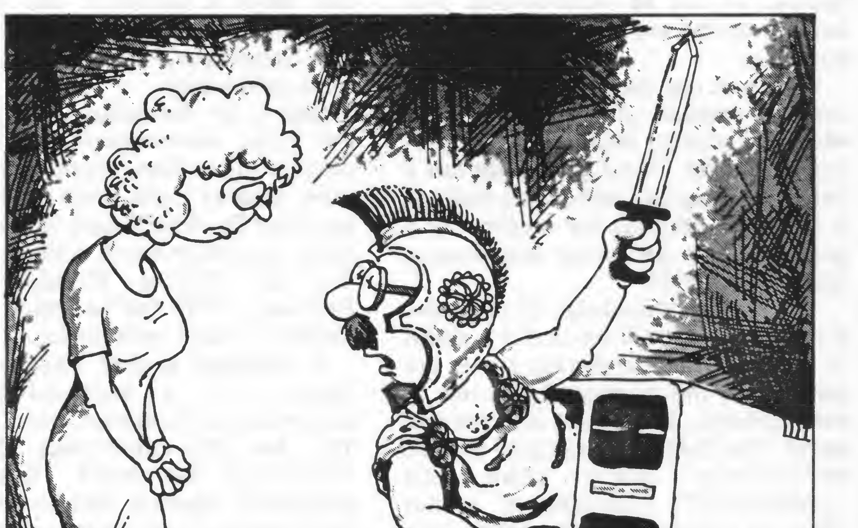
Let's take this into the future, a la *Traveller*. Instead of swords, we have blasters, rifles, lasers, and so on. All the simulated weapons would actually be low-powered lasers, each calibrated a different way to simulate different effects. Costumes would incorporate a sensing mesh, which would detect when and where a beam hit. The computer scorekeeper would have to be no bigger than a paperback book and could be worn on the helmet or in the breast pocket.

Let's assume, for the sake of simplicity, only three classes of weapons: the lightweight laser, the pistol or rifle, and the blaster. Similarly, assume only three classes of armor: the bullet-proof vest, the light-jacket, and the heavy armor.

Lasers penetrate vests well, armor a little, and light-jackets not at all. Bullets are stopped by the vest, can damage the armor, and penetrate the light-jacket easily. Blasters take out armor, and are reduced by the light-jacket or vest. Lasers are concealable, pistols and rifles are not, and the blaster is expensive. Vests are cheap, light-jackets concealable, armor is prohibitively expensive and obvious. Your choice of weapons and armor is determined by your character and his or her resources.

The computer in your costume not only knows when you've made a hit, but by what kind of weapon, and, by the intensity of the light, at what range. The computer would keep score of glancing blows, direct hits, and so on, and tell the player how much damage he or she has received, and how that would limit future actions. The computer would also keep track of recovery.

For role-playing in real life, the combination of computer and laser technologies offers many opportunities. Right now the equipment might be too expensive, and probably doesn't exist yet, but it will soon. And before too long, watch for computerized game costumes and weapons sold at Radio Shack for the price of a hand-held electronic game or calculator. ⑤



"I'M LEAVING YOU, JENNIFER."

ENTERTAINMENT TOMORROW

The Computer Goes to Hollywood

by Fred D'Ignazio and Allen L. Wold

Have you ever seen Walt Disney's *Pinocchio*? Remember when the giant whale Monstro swallowed Pinocchio and held him prisoner in a belly as big as a cathedral?

Or *Fantasia*? Remember the terrible battle between two huge dinosaurs — a Stegosaurus and a Tyrannosaurus Rex? Remember the evil creatures who came alive at night on *Bald Mountain?* Remember poor Mickey Mouse and the dancing broomsticks who tried to drown him in buckets of water?

Did you see *One Hundred and One Dalmatians*? Remember Cruella de Vil? She was the demonic woman who kidnapped the Dalmatian puppies so she could skin them for a fur coat. Remember the chase scene down the mountain, with Cruella's car spitting fire, and Cruella herself looking like an angry fiend from hell?

These were Disney masterpieces. They were full-length animated features — king-sized cartoons. Every character was drawn by hand. Each scene was drawn by hand. Dozens of artists teamed up and worked thousands of hours to produce all the still paintings that, when shown together rapidly, made the cartoon characters come alive.

The pictures were incredibly realistic. The heroes were brave and the villains were frightening and evil. Action filled the screen from start to finish.

But those days are gone. All that's left are the reruns.

Why?

Because full-length, animated cartoons have become tremendously expensive.

The Golden Age of Cartoons

In order to produce a quality animated film, artists need to draw thousands of individual, full-color pictures. Each picture might only be slightly different from the next, but it has to be completely drawn and colored.

Walt Disney Studios pioneered full-color, high-quality animated films. In the 1930s, 1940s, and 1950s, Disney had dozens of animators working turning out such classics as *Sleeping Beauty, Dumbo,* and *Snow White.*

Unfortunately, even though these movies were a great success, costs rose so fast that, after awhile, it became unprofitable to do animated films with any level of detail, craftsmanship, or quality. Almost the only type of animations that remained by the late 1960s and 1970s were the "quick-and-dirty" animations used for Saturday morning cartoon shows.

> "In the mid-1980's, thanks to the computer, animation has again become popular."

The End of the Golden Age

The cheaper animations used several shortcuts that significantly decreased their quality. For example, dozens of pictures in a row would be exactly the same, except that the characters' lips would move; or the same chase scene would be repeated several times; or the action of the characters might be jerky and ragged because the animators didn't make enough frames to capture each fine detail of the characters' movements; or the background in the animation might be blank, hastily drawn in, or repetitive.

These shortcuts made for mediocre animations, but they enabled film companies to hire far fewer animators than Disney had working for him during animated films' Golden Age.

Computer Cartoons

In the mid-1980s, thanks to the computer, animation has again become popular. The computer does not produce films automatically. Human artists still do the original artwork, but the computer helps the artist in two major ways. First, the computer helps the artist to work faster. Second, it frees the artist from lots of boring, tedious chores, such as filling in colors and painting the same, exact scene many times in a row.

Now an artist can draw an original picture — with scenery and characters — using a special pen plugged into the computer. As he or she draws, the same picture appears on the computer's TV screen and in the computer's memory.

When a picture is drawn, the artist can choose colors for the characters and scenery by touching a color contained in a "menu" of colors shown on the screen. When the artist touches an area in the picture which is to be painted that color, the computer colors the area automatically.

For example, let's say the artist has just drawn a robot and wants to make it metallic blue. She touches the blue color on the menu and then the robot. Instantly, the computer paints the robot blue.

Or, let's say the robot is crouching with a light saber in its right hand. The scene calls for the robot to leap onto a tall ledge, while holding the saber.

In the past, a good animation film would have required the artist to draw dozens of "inbetweener" pictures that showed the robot in a crouch, flying through the air, and ending up on the ledge. This would have made the

robot's jump look natural, lifelike, and realistic.

Now the artist has to draw only two pictures: the robot in the crouch and the robot on the ledge. The computer automatically draws and colors in all the in-between pictures. This saves the artist hours of tedious work, drawing and coloring in the same robot in only slightly different positions.

The World Through the "Eye" of the Computer

Today dozens of companies manufacture computer graphics terminals — computer keyboards with TV screens that make pictures.

Almost all personal computers are built so that you can plug them into your TV and make picutres. Depending on the type of computer or terminal, it might make simple black-and-white stick-figures, or it might paint realistic pictures in full color. Some computer pictures are so realistic that they look like photographs.

Lauren Carpenter is a computer scientist who specializes in teaching computers to draw realistic pictures. He works at Lucasfilm, where he helps to create computer special effects for upcoming episodes in the *Star Wars* saga.

Lauren recently taught his computer to draw a picture of a mountain range that looks exactly like a photo taken by a hardy mountaineer, thousands of feet up the sheer face of a windy, snow-covered mountain. Amazingly, the picture is completely artificial. The "mountains" in the picture are nowhere on earth. They were drawn by a computer program that was trained to manipulate numbers statistically in order to simulate a real mountain. The program creates patterns of light and shadow out of millions of numbers and hundreds of rules, then "paints" what look like mountains on the computer's picture screen.

If Lauren doesn't like the computer's mountains he can erase the screen. A few seconds later, a new mountain range will appear, compliments of the computer's "imagination."

Paint and Grow

Digital paint boxes and computers that can paint imaginary mountain ranges represent the two types of computers used in Hollywood. The first type of computer is a "Paint" machine. It enables a human artist to paint — create and color — film frames electronically. The second type of computer "grows" pictures from scratch, through the use of complex algorithms that create realistic visual images — a combination of subtle textures, contours, tones, shadings, elaborate colors and three dimensional perspectives.

The first type of computer is the tool of a trained human artist or animator. The second type of computer is controlled by a human "artist," too, but not an artist with manual talents and skills. This artist is a technician — a computer scientist or programmer — with knowledge of advanced, statistical programming techniques. This "artist" works only with algorithms, numbers, and equations. The computer actually puts the art onto a screen or a piece of paper. The computer becomes the artist's "hand."

Both types of computers are sometimes employed in the same film.

Animated Electronic Mattes

Advanced computer animation systems are used to create many of the special effects you see in today's science fiction and adventure films. During a live-action filming, movie technicians can project human actors onto scenes created by a computer. The scene is called a matte.

At one time, all mattes were created by human artists. Whenever an especially complex scene was required, a matte was painted, because a real scene would be too time-consuming or expensive to stage.

Even today, many mattes are still stationary paintings. Sections of the mattes are darkened — or masked — so that when the film showing the matte and the film showing the actors are merged, the effect is realistic. Mattes of this type were used in Walt Disney's *Mary Poppins* to show a dazzling rooftop view of the city of London; they were also used to create spectacular scenes in Walt Disney's movie *Black Hole.*

Now, computers can create mattes — mattes that move and have a life of their own. Computers can project living, human actors onto these animated mattes. The scene represented can be anything or anyplace in the universe, or it can come from the film producers' imagination.

Two studios that make extensive use of computer animation systems are Lucasfilm and Disney Productions.

Special Effects for *Star Wars*

Ed Catmull is a wizard at using computers to create special effects for movies. Recently, Ed was hired by Lucasfilm to produce the computerized special effects on future episodes of the *Star Wars* saga.

Ed spent his first year at Lucasfilm getting ready. He built several high-speed animation computers. He designed revolutionary new special effects and he hired the top artists and computer experts in the world.

Now Ed has begun teaching the computers to create animated computer pictures that will come in all colors and in three dimensions. The pictures will be inserted in the midst of live action scenes in upcoming *Star Wars* movies. They will be so exciting and lifelike, that you'll think they are real.

TRON

Walt Disney Productions' movie, *TRON*, is about a video game genius who gets kidnapped to the world inside the computer. MCP, an evil computer program, captures the hero and transports him to a bizarre "game grid" where he becomes an electronic gladiator and must constantly fight battles just to stay alive.

To produce the incredible scenes in *TRON*, Disney hired some of the most famous computer animation companies in the world. These companies taught their computers to create some of the amazing special effects.

Computer Pictures at 4 AM

Computer screens haven't always been able to make pictures. In the 1940s and early 1950s, people used computer screens as part of the computer's memory. Later, in the mid-1950s, people used picture screens as "electronic paper." For example, when a programmer typed in commands or information on the computer typewriter, a copy would appear on the picture screen.

No one knew how to make pictures on a computer screen, only how to enter numbers and words. Everyone knew computers were good at arithmetic, but no one realized that computers could translate numbers into pictures.

Then along came Ivan Sutherland. In the early 1950s Ivan was a graduate student in the Department of Computer Science at MIT. He had been lured to MIT by Artificial Intelligence genius, Marvin Minsky.

Ivan was hooked when Minsky showed him MIT's TX-O computer. The TX-O was an early time-sharing system that allowed a user to interact directly with the computer. Ivan loved sitting down at a terminal and carrying

on a conversation with the computer.

When Ivan arrived at MIT, it was summer vacation. Few students and professors were around to compete with him for the computer's time, so he spent all day on the computer. Then the fall semester began, and Ivan got bumped off the computer.

The computer was in use all during the day, but it was free every night after midnight. So Ivan, his wife Marcia, and their two children set up a new schedule for Ivan to follow. At 3:30 every morning, Marcia would get Ivan up, feed him breakfast, and send him off to the computer lab. She'd go back to bed until seven or eight, then get up with the children.

Ivan, meanwhile, would rush over to the lab, sit down at the terminal, and have the computer all to himself until the first professors and computer operators arrived around seven thirty.

The First Electronic Sketchpad

During one early-morning session with the computer, Ivan was playing with the picture screen. He had seen people type dashes on the screen, but no one, he realized, had ever programmed the computer to draw.

Ivan wanted to write a program that would cause the computer to draw a simple line on the picture screen. To do this he had to face several problems that no one else had ever faced.

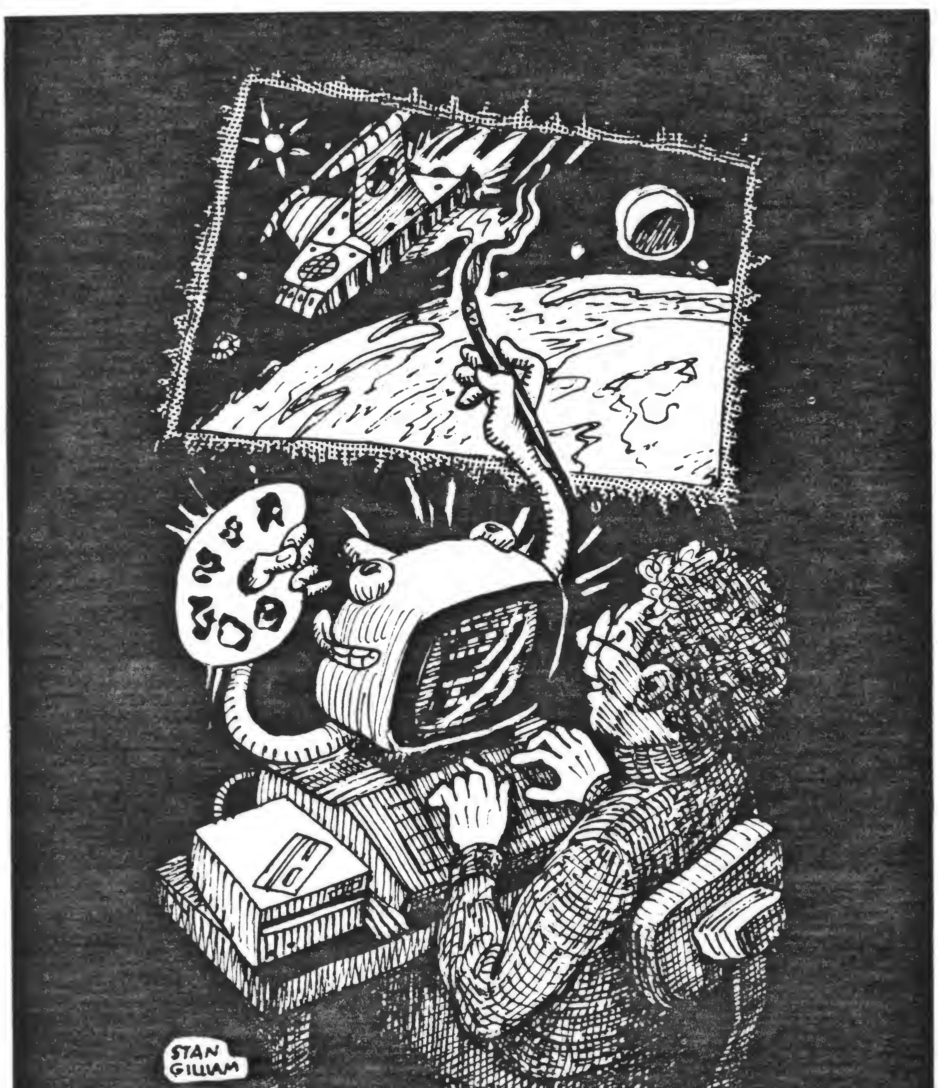
These are some of the questions Ivan asked himself: How do I describe a line to the computer? What instructions will make the computer actually draw the line? How do I tell the computer where to start the line, and where to stop it? Should the line be of fixed size, like a pole, or should it be elastic, like a rubber band?

For the next two and a half years, Ivan worked on this problem. Finally, he figured out how to make the computer draw a line. Then he found a way to make the computer draw a square, then a triangle. One day, he practically danced around the laboratory. He had made the computer draw a circle!

Ivan didn't stop there. He taught the computer to draw beautiful three dimensional shapes like spheres, cones, and cubes. He taught the computer to spin the shapes round and round. He taught the computer to shrink the shapes and to enlarge them.

Step by step, Ivan blazed a trail into the world of computer graphics. After two and a half years, he proudly unveiled *Sketchpad*, a complete computer picture-making program.

Ivan's enthusiasm about making pictures was contagious. According to Marcia, "Wherever Ivan was, people showed up and got excited. When Ivan was around, things just started happening."



Motion Graphics for the 21st Century

In the next three columns, we will continue to focus on computer graphics, computer animation, and the use of computers to make movies.

We will journey from Ivan Sutherland's early *Sketchpad* system to today's digital paint boxes and animation systems. We will end our journey with an interview of computer genius, John Whitney Jr. We will learn about Whitney's efforts to invent a "Leonardo da Vinci" computer to create totally new modes of electronic entertainment — a "motion graphics for the 21st century."

On the way, we will look at today's *paint* and *grow* computers, and at innovative studios, like Lucasfilm and Disney Productions. We will look at films that have used computer special effects — films like *Star Wars, Alien,* and *TRON.*

We will speculate about interactive "movie theatres" of the future — combinations of computer flight simulators, arcade videogames, and conventional wide-screen movies.

We will look at some of the languages and systems that are being developed, included *Zgrass,* the *Digital Paintbox*, and the powerful animation *Designer's Toolbox.*

We will examine the way computers are enabling scientists and film makers to work together to create a new generation of super-realistic TV documentaries: computer movies with dazzling special effects, all based on scientists' numbers and formulas, and on the latest scientific theories.

With computerized image generation systems we can journey outside the Milky Way, take a spin around the solar system, orbit the earth, or dive through Saturn's rings. We can also soar across history and watch the Big Bang, or witness the fleeting birth and death of a sub-atomic particle.

Out of the Dungeon

By Allen L. Wold & Fred D'Ignazio

You have entered the home of the most powerful man on the planet. He owns the Chateau, where the alien artifact you have been seeking for the last three years is hidden. He does not know it is there; you have put together the last pieces of the puzzle only a day ago. Your problem is to get him to let you into the Chateau, alone, just long enough to remove the fabled artifact.

You have come to make a deal, and confront No. 2 in his study. His manner is polite but restrained. He has tried to stop you more than once, for reasons you do not understand, as you combed the city for clues to the whereabouts of the artifact.

"You are brave to come here," No. 2 says.

"You dare not kill me in your own house," you tell him. "You would be the prime suspect."

"That is true, but I will kill you shortly, nonetheless."

"I have found the Master Key," you tell him. With the Master Key, No. 2 can become Planetary Director, and you see by his face that he wants that very much.

"I don't believe you," he says. "Lies like that will not save you."

You describe the Master Key to him briefly. It is a document of about 3000 words, detailing an elaborate ritual.

"All right," he says. "What do you want in exchange for the Key?"

"One hour alone," you say triumphantly, "in Chateau Celso."

"Impossible," No. 2 snaps.

"Why is it impossible?" you ask. You think, *what has gone wrong?*

"The secrets of the Galaxy Front are hidden in there, and I can't let you get to them before I find them."

"I don't care about the Galaxy Front," you say truthfully. "All I want is the Capellan Stone, which I have reason to believe is also hidden in the Chateau."

"Too bad," No. 2 says. "I care nothing for the Capellan Stone, but I can't let you into the Chateau."

"Come with me then," you suggest. "You can watch to make sure I don't try to find the secrets of the Galaxy Front. All I want is the Stone. Once I have that, I'll give you the Master Key."

"No," No. 2 says. "There are wards and restrictions you don't understand. I can't let you into the Chateau, under any circumstances. If you want Capellan artifacts, you'll have to be content with something other than the Stone. Now give me the Key."

Everything has gone wrong. Can you get out of No. 2's home alive? Dare he try to take the Key from you by force, even though this planet's police would be down on him within hours? You decide to try a bluff.

"I destroyed the Key," you tell him, "but I memorized it first. If you try to hurt me, you'll lose it forever. I have a very weak heart."

Currently there are three kinds of role-playing games available. First, of course, is the traditional human-moderated game, such as *Dungeons and Dragons, Tunnels and Trolls*, or *Runequest*. Then there are the games which are contained wholly within a computer program, such as the venerable *Adventure*, and all the rest of Scott Adam's fine products. Then there are the games which are half and half, in which elaborate tables and charts are contained in the machine, but a human moderator controls the objectives and flow of the game.

Human-moderated games are the most flexible. Players can go anywhere, change their objectives in the middle of a game, and the unexpected is always possible. However, anyone who has looked at the massive rule books for *D&D* or *Chivalry and Sorcery* knows that the amount of material which must be learned before playing is tremendous. A good deal of time is spent rolling dice, consulting tables and charts, and making interpretations. A dedicated moderator, willing to forgo play in order to make the game work, is absolutely required.

On the other hand, the computerized adventure-type games require no work at all. The player can simply explore the cave, the pirate's island, or the asylum, with no concern for dice, combat results tables, wandering monster charts. The problem here is that there is no flexibility. A player cannot go beyond the bounds of the game as designed.

The third form offers the most flexibility, though there are few games of that type yet available. Here all the tedious work is handled by the computer, leaving the moderator free to design an adventure, and the players freedom to play. Only the constraints and rules of the imaginary world are in the computer, not the plot or the objectives of the adventure.

One problem with all types of fantasy role-playing games (FRPs) is that they are primarily restricted to themes of simple action adventure. The player or players wander through a strange world, defeating adversaries, usually by combat, and garnering rewards in the from .of treasure or experience points. (A notable exception is the game *En Garde!*, where one need not fight at all, the world is very familiar, and the objective is to acquire status.) This is true whether the background of the game is pseudo-medieval, interplanetary, or contemporary espionage.

This is due in part to inertia. The first great game was *D&D*, and game designers, no less than television producers, imitate success.

The greater reason, however, is that when one is on an adventure of exploration and treasure-hunting, the other non-player characters (NPCs) one meets need be portrayed in only the simplest sense, unlike No. 2 in our scenario above. Even in human-moderated games, where the moderator assumes the role of the NPC, this is the rule.

One of us, Allen, has run a dungeon, and it is extremely difficult, if not impossible, to effectively portray several dozen different NPCs, even if they are only briefly on stage. In computer games, the NPCs have no personality at all.

	Stand	Right	Left	Attack	Retreat
Stand	10%	20%	20%	25%	25%
Right	5%	15%	25%	30%	20%
Left	5%	25%	15%	30%	20%
Attack	0%	25%	25%	40%	10%
Retreat	20%	15%	15%	10%	40%

Figure 1

In an earlier column, we discussed the possibility of board games containing all the tedious tables. leaving the player free to plan strategy and tactics — in other words, to play the game. Fantasy role-playing games of the future will most certainly be like this, what we call Computer-Assisted Role-Playing Games (CARPGs). The advantages are obvious.

Such a CARPG will present the players with a situation, in which there is a problem to be solved, and will provide all the background, all information, the results of any action taken, and all other characters, the NPCs. Our scenario is an example of what such a game might be like.

Eventually, even the necessity for a live moderator will disappear, when the computer can take over the chores of plotting, continuity, and most importantly, the portrayal of NPCs.

We need not concern ourselves with how this will be reproduced graphically or with sound effects. That is another topic, and we will assume for the moment that such a game will be amply provided with both. We mention them now just to indicate we haven't forgotten them.

As we can see, one of the major problems in providing such a game is the creation of NPCs which behave realistically. We can chose plots/themes. The computer can keep track of all the details, role the dice, and enforce the rules. But NPCs with behavior is the sticking point.

By behavior, we mean that the NPC, whether a troll or something like No. 2, does more than just attack, steal treasure, or impede one's passage. The NPC responds to the player, and that response is essentially unpredictable and complicated.

Eliza is a program which plays the role of a psychiatrist, and there are other similar programs. They are all very complex, very long, and require lots of memory. Even such programs are limited, in that their behavior is deterministic. A true NPC's behavior will not be absolutely predetermined, but will make use of random weighted probability tables.

This is a complex subject, but we'll try to present it simply. Let us assume the player has met an NPC. In the most basic form, that NPC has a few "states." A state is what the NPC is represented as being or doing at the moment.

In our example, the NPC has five states: Stand Still, Move Right, Move Left, Attack, and Retreat. The game designer assigns certain probabilities to each state, so that, for example, the NPC will stand still 10% of the time, move right or left 20% of the time each, attack 25% of the time, or retreat 25% of the time. Whatever it has done in the past bears no relation to what it will do next. The chances of any action, the probability of any state, are the same at all times.

More complex behavior is possible, making use of what is called a Markov Chain. In this case, the NPC moves from one state to another, as before, but the probability of any future state is dependent on its present state (or last movement). This is best shown with a table which you can see in Figure 1.

The column on the left represents the state the NPC is in, or, in other words, the action the NPC took the last time. The row across the top represents the states the NPC could take the next time. The percentages in the table, called transition probabilities, represent the probability of the NPC moving to any future state, given a present state. As you can see, this makes the NPC much more interesting.

There is still a higher level of behavior, which is much more complicated. The NPC using a Markov Chain remembers nothing. That is, its state of having moved left the 72nd time is the same as its having moved left the first time. If we provide an NPC with "memory," then we might have the effect that the NPC will move left no more than three times in a row, or if it has retreated once, it will never attack.

By adding to the number of states, and by adding memory to the NPC, we can come up with very complex behavior. We are approaching the realms of Artificial Intelligence, which we will discuss in more detail in a later column.

Another question is, how to construct these complicated tables, not only for character behavior, but for other elements in the environment. Most events do no occur in a truly random fashion, but according to rules which modify chance. (For an excellent discussion of how the principles of nature govern chance, see *Laws of the Game*, Eigen and Winkler, Knopf, 1981.)

To provide a truly believable CARPG, real-life situations must be accurately simulated. This kind of research is, of course, already being done. Business, politics, physics, and other disciplines make extensive use of simulations. In the realm of games, see the massive rules for *Chivalry and Sorcery*. But of all simulations, that of human behavior is most difficult.

Most NPCs will be only met briefly, and need not be very complex. A band of "orcs" will be similar to each other, though each individual will be controlled by its own set of charts. Randomly-met humans can all behave in a more or less typically human way, but there must always be the oddball, and there must be the more important characters. The tavern keeper, the starship captain, the woman with the clue to the mystery, must all be distinct individuals.

The technological and programming skills necessary to provide truly believable NPCs are formidable, though not out of our reach. But there is still a limit to what can be done by people whose business is programming or game design.

What are needed are good story situations and real characters, developed by people whose business it is to provide such — that is, professional authors.

Movies are made from books and

stories. There is no reason FPRs or CARPGs can't be made the same way. This provides a much broader range of theme, plot, character, situation, and so on. Some SF novels or stories which might well be made into FRPs include *Hammer's Slammers*, by David Drake, any of the Kane books by Karl Edward Wagner, *ESPer*, by James Blish, or the Amber books by Roger Zelazny.

In a short story, there is a single objective, and the failure or success in achieving that objective brings the story to a close. In a novel, on the other hand, the major objective is not always clear, and situations arise which require the character to seek short-term objectives. A properly-designed game, the product of the cooperative effort of storytellers, programmers, and game designers, will not have these short-term goals built in, but will be able to provide them as needed. Needless to say, the design, production, and execution of such a game will be extremely complex.

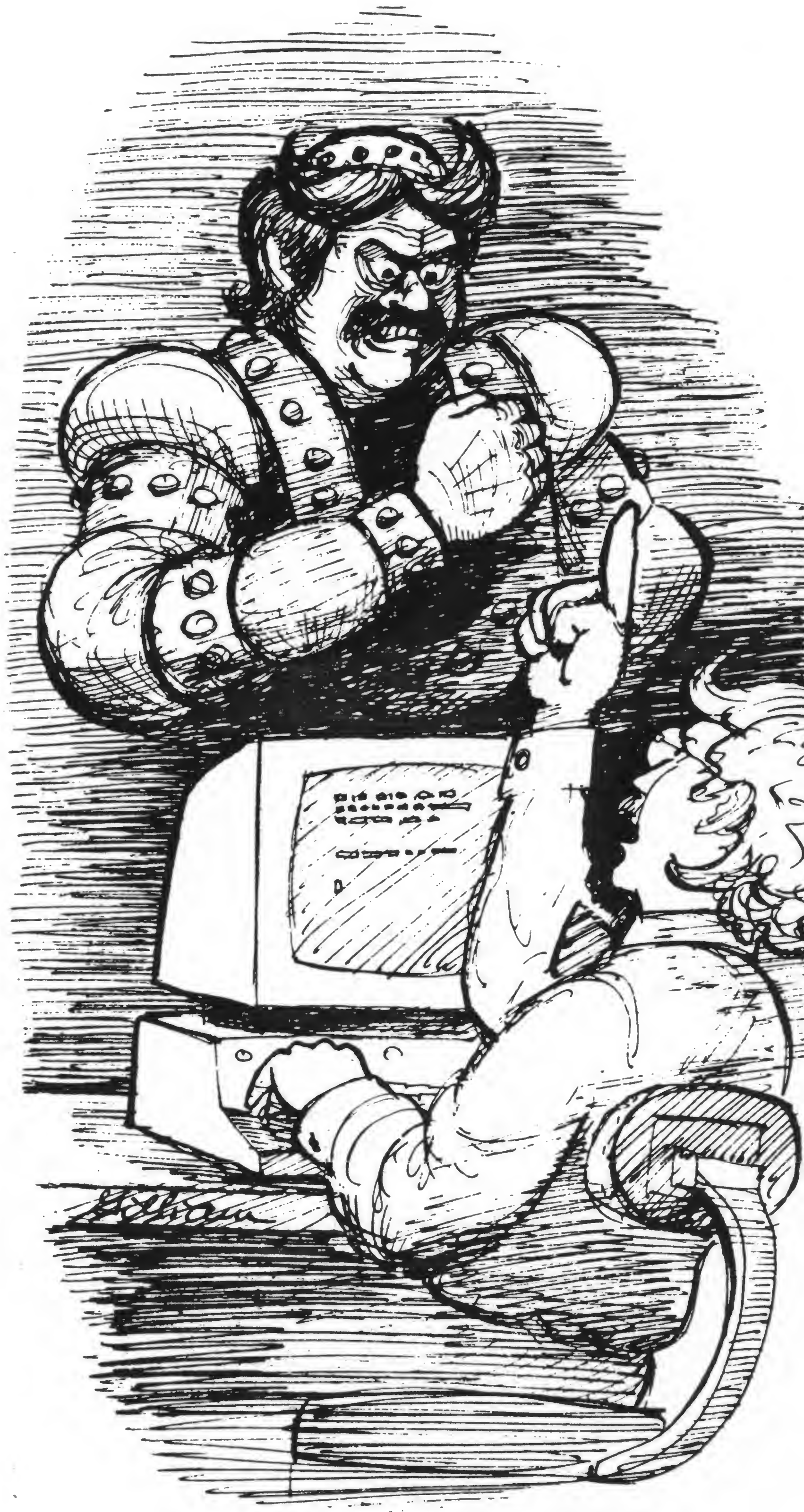
It is just a matter of time before we will see CARPGs with a broad range of general themes, such as mystery, romance, western, soap-opera-like contemporary life, true science fiction, true fantasy. Once a player has chosen such a theme, he or she will then have the ability to choose a prime objective, such as the accumulation of wealth, the achievement of power or fame, discovery, revenge for past wrongs, romantic and/or sexual fulfillment, and so on.

The player will also be able to chose his or her own character, which could ressemble that player in varying degrees, or which could represent entirely different roles. The computer would assist in playing those roles, based on programs written by people who understand psychology and human nature.

At the same time, the player will be able to decide just how difficult a problem will have to be solved, the number of obstacles to be conquered, and the degree of opposition from "nature" as represented by the game's program.

Assisted by the computer, the player will be able to live out fantasies, not just in the imagination, and not in real life, but on a computer. Fantasizing is a problem-solving activity, and with computer assistance, the constraints on the problem can be realistic, and the validity of the solutions checked against reality. Needless to say, the entertainment aspect of this kind of activity would be immense.

This is a long way from the dungeon.



We have only touched on a rich and complex set of ideas, which we hope to develop in more detail at a later time. The point is that fantasy role-playing games, as they are today, are just the beginning. One of the first steps toward achieving the ultimiate, as described by Arthur C. Clarke in *Against the Fall of Night* and *City and the Stars* is the development of truly interactive characters. Work on that has already begun.

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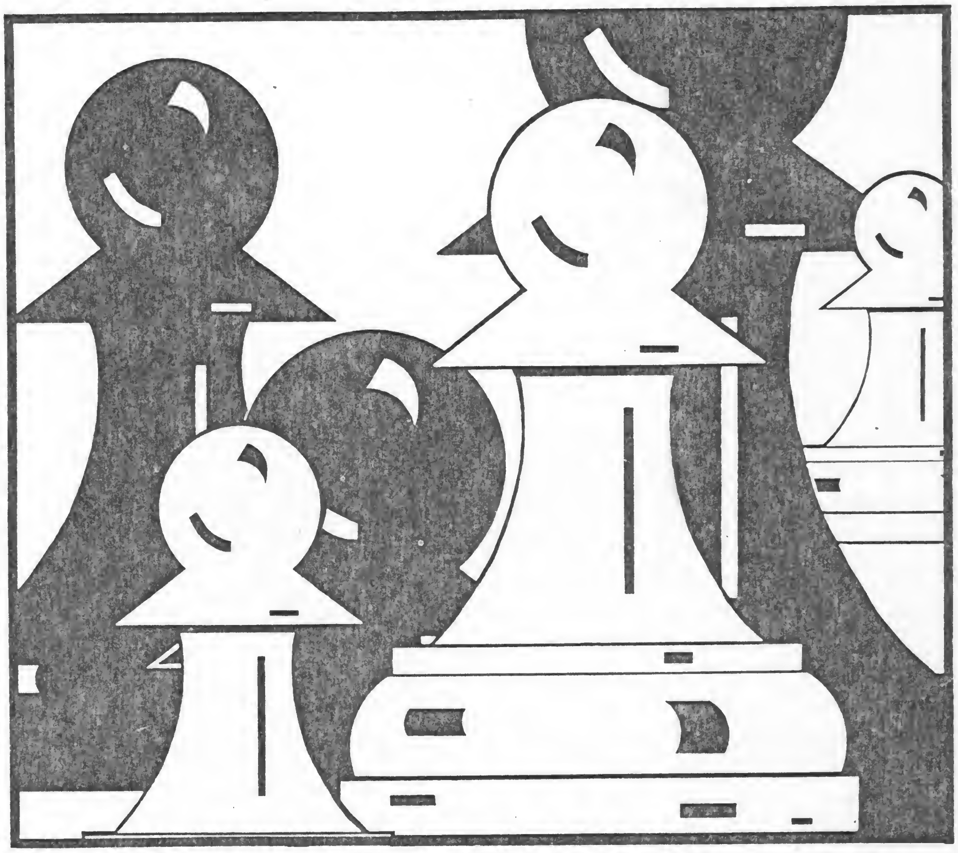

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FRONT RUNNER

FEATURES

SPECIAL FEATURE

The Third Dimension

By Allen L. Wold and Fred D'Ignazio

C3PO and Chewbacca sit across a round table, the top of which is divided into concentric segments. Holographic chess pieces, in the form of strange alien creatures, move at the push of a button. They march across the "squares," threaten each other, and fight animatedly.

But it's all done with trick photography.

Still, we recognize the pieces as holographic images, projected somehow onto the surface of the table. Holographic techniques are improving rapidly, and someday a game very much like that will be possible — won't it?

Unfortunately, it's not a matter of technology, but of physics. The game in *Star Wars* is not likely ever to be realized. To find out why not, let us take a very brief look at how holograms are made, look at some alternatives, and then see what holography can do.

Holograms are produced by laser light, which is both extremely monochromatic (single-color), and focused so that the rays are all parallel to each other. A beam of laser light is split in two. One beam, the reference beam, shines directly on the holographic plate (very much like regular photographic film). The other beam shines on the object to be reproduced, and is reflected onto the plate.

When the direct and the reflected beams strike the plate, they interfere with each other, producing a very complex and visually unintelligible pattern. However, when the developed plate is later illuminated by a laser beam similar to the one by which the plate was exposed, a three-dimensional image is produced.

The technology to make holograms is quite complicated, and further discussion is out of place here. Suffice it to say that there are basically two kinds of images — those which appear behind the plate, and those which seem to stand out in front of the plate.

If you're interested in the subject, one good book is *Understanding Holography* by Michael Wenyon (NY Arco, 1978).

Let us first look at projection holography, where the image is made to appear on a table top or other surface, as was represented in *Star Wars*. This is quite possible today, but is subject to certain physical limitations inherent in the nature of holography, rather than in the technology used to produce it.

The first problem is that although images can be projected onto a flat surface (or into mid-air for that matter), when they are viewed from any angle other than that by which the light leaves the plate, they aren't there. While certain forms of transmission holography, involving a cylindrical plate, allow you to see an image from many directions, you can't see the image of a projected hologram if you are even slightly out of line.

Secondly, the size of a holographic image is dependent on the size of the plate which produces it. The image can be no larger than the plate itself, though it can be viewed through magnifiers. Still, with magnifiers between the viewer and the image, it is as if the image were in a TV box, not standing above a table. And the magnifiers must be nearly as large as the desired image. This is true whether the image is projected, or seen through the plate.

The plate size also determines how far the image can be projected. A plate 12 inches on a side will project the image about six inches in front of it. To project an image six feet away would require a plate nearly 12 feet across.

Thus, the size, distance, and viewing angle of the images are directly related to the size of the film, and the angle through which the light passes to form the image.

This leaves us with looking at holographic images in a TV-like box, instead of floating free. Here technology can do something about the size of the image formed. There is no reason why a hologram couldn't be as big as a living room wall. And while most holograms today are monochromatic, they can be made in color by projecting three images as is done in color television. But there are still problems and limits. For example, while it might be relatively easy to make a holographic movie, holographic TV is something else.

TV images are broadcast at the rate of 30 per second. Each image contains considerable information, thousands of dots of light, in thousands of differing levels of brightness. A hologram, by its physical structure, contains about 300,000 times as much information as a TV picture of the same size. The time required to produce a one inch by one inch image is, at present, about two hours. A hologram large enough to fill the screen of a 19-inch TV would require several times as long to produce. And that would be for just a single "frame," not the 30 frames per second required for the same quality of illusion of movement that a TV would produce.

For the moment, we'll have to content ourselves with prerecorded holograms instead of live broadcasts. This does not take into consideration the difficulty of making a hologram in the first place, which requires absolute darkness except for the laser light illuminating the subject. This is not to say that such a broadcast will be impossible in the future, but it is the far future indeed.

Before we go on with holograms, let us look at some alternatives. One possibility is a system of computer controlled 3-D images which makes use of a rapidly moving mirror, which reflects a different layer of space-filling image at each position. The mirror moves so quickly that there is no flicker, but the systems cost around $100,000.

Some electronic games available today use perspective drawings on an LCD display, such as *Escape 1000 Mazes*, or the arcade game *Red Baron*, which uses similar drawings on a CRT. Many computer games make use of perspective drawings to enhance the

sense of three-dimensionality. If there is color available, color code could be used to enhance the sense of depth — the redder, the closer; the bluer, the farther away. But this is only a representation, not a true 3-D image.

And there is the old standby, the stereoscope, where the viewer uses special glasses so that two slightly different images are seen each with only one eye. The same principle was used with the so-called 3-D movies. But again it is only an illusion. One's perspective does not change as one views the image from different angles.

Chess can be played in three dimensions. One way is to use one board for each level, laid side by side. But it is hard to perceive the 3-D relationships. (You can even play four-dimensional chess this way, which is even more difficult.) A game on the market uses three boards, each 8 x 8, suspended one above the other by a rack at one side. One author, Allen, has a "board," which consists of five surfaces, each divided into 5 x 5 squares, forming a cube. An 8 x 8 board would be equally possible.

There are a number of board games on the market representing conflict in space. In some of these the strategy is emphasized, as in *Imperium* or *Triplanetary*, and three-dimensionality is relatively unimportant. Several others, however, stress the tactics of combat. *Battlefleet Mars*, for example, has a double board on which three dimensions are represented. *Starforce*, on the other hand, represents the whole cluster of nearby stars on a flat field, with special rules for simulating the third dimension.

Space is three-dimensional, and flat playing surfaces represent this only imperfectly. The problems of keeping track, by using two boards for XY and XZ planes, or code letters representing levels above or below the playing surface, are not very visual, and interfere with play.

While three-dimensional boards, such as for chess, might be built, space games usually require more than five or eight spaces in any one direction. Thirty or 40 units in each dimension is more typical. But such a board, constructed of card or transparent plastic, would be too cumbersome to use. How do we move that piece right in the middle, with tongs?

At the moment, the only solution is to produce the images in a kind of tank, or TV-like box, permitting viewing only from the front. The inside is hollow, and at the sides are the various holographic plates and the source of laser light which produces the images. Thus, you see the images as if you were looking through a window.

Whatever game is to be played using this device, we assume that all tables, moves, combat, and so forth are controlled by, or at least moderated by a computer, as we described in an earlier column. There are no dice to roll, no combat tables to look up. The players don't actually touch the pieces. They simply key in the desired movement or action, and the computer performs it.

One other holographic trick must be mentioned, and that is that a single holographic plate can contain up to 100 separate images. When the plate is illuminated, only one image is seen, depending on the angle of the light. To see another image, the light is moved slightly, and a different image appears.

Under computer control, a set of holographic images could be presented according to the outcome of game decisions.

Thus, under computer control, a predetermined set of images could be presented in any order, according to the outcome of game decisions. Several different plates, each with a hundred images, could be switched back and forth in front of the laser.

In a space game, one holographic plate could contain the images of stars in their relative positions. Seen through the TV-like window, they would appear truly three-dimensional. As the player's position in space changed, different star images would be produced, giving the view as it might be from any new location.

Another plate could contain images of starships, which would be superimposed over the star-field image. As the ships move relative to the stars, the computer would present different images representing their different positions. This might require one plate per ship, but since the image would be small, a frame could hold dozens of holograms, each one with a hundred ship positions.

Holographic plates can be made of plastic, and mass-produced, and can be made quite large. The expense of production would be subject to technological development and marketing, and could conceivably be brought to reasonable levels. One might then see a game like *Star Force*, in which one sat before a rather large box, and saw all the stars within 15 light years displayed in natural color and proper brightness to indicate size, within the black volume of space.

Fleets or single ships would be tiny spots of light, positioned among the stars, and moving, according to the player's instructions, in a truly three-dimensional fashion. Whenever ship-to-ship combat was desired, the computer would store the position of all ships and present an image at a much smaller scale, representing perhaps only one light minute on a side. Any type of ship movement would be possible, and aiming and firing, maneuvering and damage, would all be produced using a second set of holographic plates.

A solitaire game of space combat could be produced in which the player's view is from the bridge or cockpit of his fighter, similar to that of *Red Baron*, except the image would be truly three-dimensional. What the player would see is what's "out front." Computer-controlled enemies would move, and the player would have a true 3-D image of enemy vessels flashing past, his missiles and beams searing off through space.

But we don't have to limit ourselves to space games. *Dungeons & Dragons* type adventure games could easily take advantage of 3-D holographic imaging. The restriction to a box is no problem, since most of the action in such games takes place in a room or section of dungeon anyway. Outdoor adventures would be more difficult to produce, but not impossible.

As in the space games, one set of holographic plates could produce the images of the environment, a second set would display the adventurers, with perhaps a third set for the monsters, treasures, and movable furniture.

Full motion would require an excessive number of image plates, but "stop-action" scenes would be easy. Your hero could be in any part of the room, in any position, and the computer would select which image to present depending on your instructions. It could display a magician casting a spell, warriors fighting a troll, and accommodate the player-characters carting off treasure.

Holographic imaging is not — yet — the perfect answer to truly three-dimensional games, but even with its limits, there is a lot of potential.

FAMILY FARE

ANIMATION & ADVENTURE...FOR THE WHOLE FAMILY

Editor's Note: Fred D'Ignazio is a contributing editor to Video Movies. *He has also written a number of computer books for children and appears as a regular commentator on ABC TV's "Good Morning America." He will be writing reviews and essays for* Family Fare.

The New Dark Stories

When my children were younger, I'd put them to bed each night by turning off the lights and telling them a *dark story.* Dark stories were tales I made up myself with my children cast as the hero and heroine. Later, as the children got older, they seemed less interested in listening to my dark stories. The stories that seemed suitable for Catie (eight) just didn't seem interesting to Eric (five).

I was feeling sad about not being able to tell those stories anymore, and felt something was missing from our nighttime rituals. TV didn't work because I didn't like most of the programs that were on before my children's bedtime at 8:30 pm.

That's when we purchased a VCR and began watching movies together. The movies have become like new dark stories for our family. We watch them in the dark, and the kids use Janet (their mother) and me as pillows to cuddle up to while we all watch together. We usually end up tickling someone's back, leg, or arm before the movie is over. All in all, it's become a very pleasurable, intimate family experience that's even better than the old dark stories because Janet joins in too.

When my family and I watch video movies we are having fun together, but we're also doing something else that's important—replenishing our imaginations. I think of an individual's imagination as a well of cool, crystal pure water that can easily run dry unless new springs frequently refill it. One of the ways to replenish the imagination's well is by having rich experiences. Another way is to read good books or to listen to music. I think a third good way is to watch movies.

Movies send me and my family to faraway times and places. We get to meet people we have never met before, see sights we have never seen, and hear sounds we have never heard.

When we watch movies we're thrust into dramatic situations that make us feel strong emotions. I think we—as human beings—are like a fine instrument capable of a broad range of emotions. As the emotions are felt, the instrument is played. Collecting these emotional experiences through books, music, or movies helps tune the instrument.

The movies we've seen in the last month have had a profound effect on my five-year-old, Eric. Several times a day he's either asked questions about a character in a movie, sung a song picked up from one of the movies, or playacted a character's role that he's seen. Since young children haven't yet had the opportunity to travel broadly, or experience many aspects of life, movies let them vicariously share in these experiences. In this way my children can travel to places they might otherwise never go, and meet people and creatures they may never meet in real life.

Even the youngest children can benefit from movies. New studies are confirming that young children feel a broad range of emotion even before the age of four, and they are more outward-oriented and caring than was once thought. I know Eric is experiencing the movies deeply. I have seen him cry over movies like *E.T., Charlotte's Web,* and *Ringing Bell* (reviewed in last month's issue). I believe that good movies are like exercises for Eric's imagination and emotions. Experiencing movies helps them become stronger, more balanced, and more developed. And watching video movies with my children allows me to share in that process.

—FRED D'IGNAZIO

◄ *Dishonest John.*
Beany & Cecil. ►

Beany & Cecil

VOLUMES I AND II
(1961-1963), C, *Animated.* RCA/Columbia, **$29.95.**

If any cartoon is a reflection of its time, it's *Beany & Cecil.* When future historians unearth these cartoons, they'll get some sense of what was going on in the U.S. during the late 1950s and early 1960s, at least as seen through the eyes of zany cartoonist Bob Clampett. The image of America that emerges from these cartoons is similar to the image seen in the reflection of a funhouse mirror. We recognize ourselves in the mirror, but we look silly and stretched out of shape.

When I was growing up (during this same era), I read newspaper stories about UFOs and aliens invading the earth. I played cowboys and indians, read *Superman* and *Davy Crockett* comic books, and watched my heroes and villains on television. I went to the theater and saw movies about robots and evil computers. I watched Jackie Gleason on TV and I watched the astronauts taking off from Cape Canaveral (and dreamt about the day America would finally send a man to the moon). I was also fascinated with the ragged, weird-looking beatniks that started crawling out of basements and bars in Greenwich village.

All these characters and motifs are chronicled in *Beany & Cecil* cartoons. I see them all, once again, when I gaze into Bob Clampett's wacky funhouse mirror. The cartoons are about the adventures of Beany, a fearless, blond-haired kid and Cecil the "seasick sea serpent," who looks more like a cute sock puppet with a button nose than a sea serpent.

Beany and Cecil go on their adventures in an old boat called the *Leakin' Lena,* accompanied by black-bearded Uncle Captain and a crow that keeps following them from the ship's crow's nest. The adventurers sail around the world looking for danger, fame, and fortune. When they go on dry land, the *Leakin' Lena* converts into a prairie schooner that Cecil pulls.

Each tape (Volume I and Volume II) contains six episodes. In "Spots of the Leopard," Beany and Cecil go on a jungle safari to capture a leopard. In "Invasion of the Earth by Robots," "Little Ace from Outer Space," "Strange Objects," and "A Trip to the Schmoon" astronauts, aliens, robots, and outer space prevail. Beatniks are transformed into "The Wildmen of Wildsville," and Davy Crockett becomes "Davy Cricket." Jackie Gleason makes an appearance in "A Trip to the Schmoon," and Walter Brennan (of TV's "The Real McCoys") appears as Pop Gun, an ornery, old Indian fighter.

My children liked *Beany & Cecil* because of the cartoons' nonstop action, the suspense, and the silly rhyming (for example, the robot mother in "Invasion" is Venus the Meanest and her robot son is a menace named Venice). And they also liked the battle in each episode between good and evil. In most episodes evil appeared in the person of Dishonest John, who charmed my children by constantly chuckling, "Nyah, Ah, Ah!" As bad as John is, and as fiendish as his plots are, when he gets laid up in the hospital (in "Grime Doesn't Pay" and "Strange Objects"), Beany, Cecil, and Uncle Captain pay him a visit and bring flowers.

As an adult, I have to admit that I could not sit through more than one or two repeat performances of these cartoons. But there are some rewards. If you like puns, you're in for a treat. Clampett's puns are everywhere and outrageous. One of the episode titles, for example, is "The Capture of Tear-Along the Dotted Lion," a story about a lion bodybuilder who runs a "jungle gym" for muscle beech trees. To get to the Vitamin Pill Hill where the lion works out, Beany, Cecil, and friends have to sail through the Sandwich Isles (that look like baloney sandwiches), Thousand Islands Dressing (literally), and the Vitamin Sea.

Don't buy these cartoons expecting your kids to learn anything. They're fantasy: Rockets are launched by robot hands that squeeze the spaceships out of a giant banana peel. But they'll make you laugh, and younger children (ages three to eight) will want to see them over and over again.

—FRED D'IGNAZIO

King Arthur and the Knights of the Round Table.

King Arthur and the Knights of the Round Table

VOLUMES I AND II.
(1981), C, *Animated.* **60 min.** *G.* Family Home Entertainment, **$49.95.**

After only a couple minutes of watching *King Arthur and the Knights of the Round Table,* I was hooked, along with my eight-year-old daughter. The story is about how Arthur became ruler of Camelot and king of England. It begins with the nighttime murder of Arthur's father and Arthur's narrow escape, and ends (in Volume II) with Arthur at the height of his power, monarch of Britain, surrounded by the faithful knights of the round table.

I liked this tale even though the animation is a bit wooden and the characters are handled with a heavy, humorless hand that at times makes it seem like watching a soap opera. Its redeeming grace is the dramatic and powerful mythic story. The forces of evil are active and nearly overwhelming from the moment the tale begins, and it takes all the courage, cleverness, and might Arthur and his allies can muster to combat them.

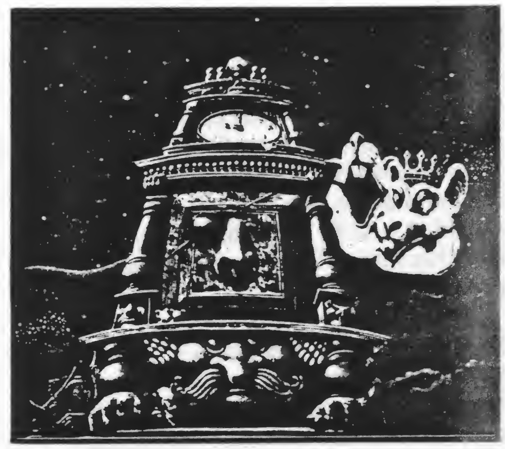
This movie is too heavy and serious for younger children. It left my five-year-old restless and bored, but it captured the interest of my eight-year-old daughter.

—FD

Nutcracker Fantasy

(1981), C, *Animated.* RCA/Columbia, **$39.95.**

If you are having trouble getting your children to bed on time at night, you might want to show them this movie. At night, after all the good children have already gone to sleep, an evil Rag Man comes out, prowling the streets of the city, searching for bad children who are still awake. When he finds children, he touches them with his fearful, magic wand and turns them into mice. Then he captures them and carries them away.

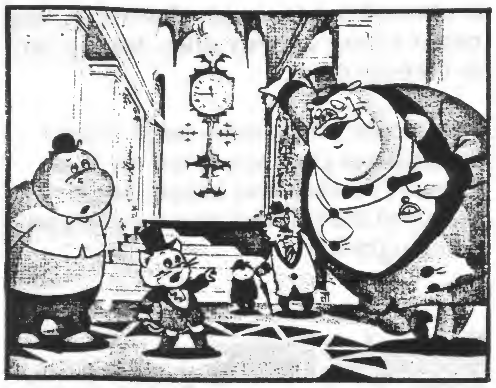


Nutcracker Fantasy.

This is a masterful puppet musical, based on Peter Ilich Tchaikovsky's ballet music and on E.T.A. Hoffman's *The Nutcracker and the Mouseking* (a tale of a heroic prince who rescues a beautiful, sleeping princess from wicked mice). Michele Lee narrates, Roddy McDowell is the voice of the prince, and Melissa Gilbert is the voice of Clara, a young girl who dreams of the princess.

The puppets are elaborately sculpted and manipulated in a fluid, lifelike manner. The music and the scenes are hauntingly beautiful. This is the best puppet movie my children and I have seen.

—FD



Puss 'n' Boots.

Puss 'n' Boots Travels Around the World

(1982), C, *Animated.* RCA/Columbia, **$29.95.**

Puss is just a humble waiter when the story begins. Sir Rumple Hog, the wealthiest animal in the city, comes to Puss' restaurant and brags that no one can go around the world any faster than he and it took *him* a year. Puss claims that he can make it around the world in just 80 days. Sir Rumple Hog bets his entire fortune that Puss cannot do it.

Puss and his friends outfit a ship and sail off from the city on their journey. They are pursued by three cats who wish to kill Puss because he has befriended mice, and, in their eyes has become a traitor to all cats. Also, Puss must be on guard against a fiendish agent of Sir Rumple Hog who tries to waylay Puss.

This is a marvelous movie even though the script is a little weak (it focuses mainly on running and chasing). Everything else is superb, in particular the visual quality of the animation. The places Puss and his friends visit are beautifully drawn and colored. The scenes are fresh, detailed, textured, and arresting. There are lots of special touches, like the way the sunlight softly bathes the Leaning Tower of Pisa. And the perspectives throughout the movie make you giddy —spires that leap into the sky, and sand dunes in the desert that are impossibly steep. The sharp angles and three-dimensional perspectives increase the drama of both the quest and the pursuit, and they make the viewer feel like he or she is on a roller coaster ride.

—FD

The Red Balloon

(1956), C, *Director:* Albert Lamorisse. **34 min.** Embassy, **$39.95.**

This classic children's film tells the story of a small boy and the red balloon that becomes his best friend. How can a balloon be a boy's best friend? As this film demonstrates, anything is possible in a child's imagination.

The story begins realistically; the boy climbs up a lamp post to retrieve a stray balloon. From here we move into the world of poetic fantasy as the relationship of the child to the balloon evolves from one of ownership to one of friendship. The boy's love endows the balloon with animate qualities as it attaches itself to the boy, following him with devotion and free will.

The Red Balloon makes magic of the commonplace—something that children do every day of their lives. But this world of innocence is not without its villains. The "bad" boys want to steal the red balloon. The villains succeed in destroying the red balloon, but out of that destruction rises a dream more beautiful than the original; the child is lifted up into the blue sky by a host of colorful balloons.

Color is used effectively and symbolically in this film. Often the red balloon is the only patch of color against a gray, drab landscape. The story is told without narration or dialogue, and can be enjoyed and understood by even the youngest child. This is a story parents will enjoy watching too.

—MS

1001 Arabian Nights

(1958), C, *Animated.* RCA/Columbia, **$39.95.**

The star of this cartoon adventure is the nearsighted Mr. Magoo. In this story Magoo (with the voice of Jim Backus) is known as "Azziz" Magoo, an honest but half-blind lamp dealer in the city of Baghdad. Magoo's nephew, Aladdin, falls in love with the beautiful princess Yasminda, but finds that she is betrothed to the Wicked Wazir, a sleazy character with a wrinkled mustache and a long, pointed nose. Aladdin tries to win Yasminda away from the Wazir. The Wazir tries to thwart Aladdin, and Magoo manages to bumble his way good-naturedly through it all.

There is nothing extraordinary about this film. On the contrary, the animation, the characters, and the script are all very ordinary. But somehow the movie succeeds. Aladdin and Magoo are lovable and the big surprise is the genie of Aladdin's lamp. He's like no genie you or your children have ever seen.

—FD

White Mane.

White Mane

(1952), B/W, *Director:* Albert Lamorisse. **38 min.** Embassy, **$29.95.**

This is an earlier film by the director of *The Red Balloon.* The story takes place in the marsh lands at the mouth of the Rhone River in the south of France. A beautiful white stallion named White Mane leads a herd of wild horses. The ranchers of the land long to possess White Mane (the herd's leader) as does a young boy named Falco. It seems to be a recurrent theme in Albert Lamorisse's films that men cannot abide beautiful things that run free. They must be captured and contained even if it means their destruction. The young Falco is not immune to this desire to possess, but at least his longing for the horse stems from love and friendship.

Actually, this theme is not uncommon in children's films. Perhaps it is because children need to learn that they cannot possess everything they desire or admire. However, be prepared for the fact that this film may make your child want a horse.

Technically, *White Mane* is a lovely film; it's beautifully photographed in black and white, and is an aesthetic delight. Unfortunately, the film is probably too slowly paced for today's child.

—MS

Family Fare *was written by Fred D'Ignazio (FD) and Maria Sosa (MS).*

Is There a Robot in the House?

ONE FAMILY'S LIFE WITH TOPO

BY FRED D'IGNAZIO

As a waiter, Topo the robot could drive you bananas—as a pal, he's just great.

In science fiction, robots do everything—walk the dog, prepare meals, and generally make life a whole lot easier. In real life, today's home robots aren't quite so helpful.

But while robots like Topo (from Androbot) aren't very advanced, they can still make life extremely interesting.

ENTER Contributing Editor Fred D'Ignazio and his family have lived with a Topo for a year. This story tells what it's like when a robot moves in.

WAKE-UP CALL

"Good morning, folks. It's 6 AM. Today..."

I rolled over in bed and smacked the off switch on the clock radio. Quiet as a mouse, I slipped out of bed and into my study. I turned on the Apple computer, grabbed the joystick and floored it.

Nothing happened. Topo, our three-foot-tall new home robot, didn't move an inch. I had forgotten to turn on the rest of the equipment.

I flipped on the radio antenna on top of the Apple, then went over to Topo and punched his green button. His backside lit up like a Christmas tree. I leaned on the joystick and Topo lurched forward.

I pushed the joystick and Topo knocked down a stack of books, swiveled around, and came rolling back toward me at top speed.

Topo's mission was not exactly going as planned.

Sometimes you have to give your robot a helping hand. I carried him to the door of my study. Pushing the joystick forward, I watched Topo disappear through the doorway, heading for my daughter Catie's bedroom. His mission: enter her room, roll up to her bed, and do a robotic flashdance to wake her up. (Topo is a good flashdancer. You just jiggle the joystick back and forth.)

I knew that Topo couldn't see

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where he was going. The problem was that I couldn't see where Topo was going, either. A prisoner of the joystick, I was on a very short tether to my Apple computer.

So I had to guide Topo based on where I thought Catie's bedroom was. The loud clunks I heard every time I ran Topo into the wall told me when I was wrong.

After I had awakened Catie, I planned to turn Topo loose on my son, Eric. Both Catie and Eric are ferocious when you wake them up in the morning—like a pair of half-starved lions. That's why I was sending Topo to do the job. The kids could grumble at him for waking them up. He never stops smiling. His smile is painted on.

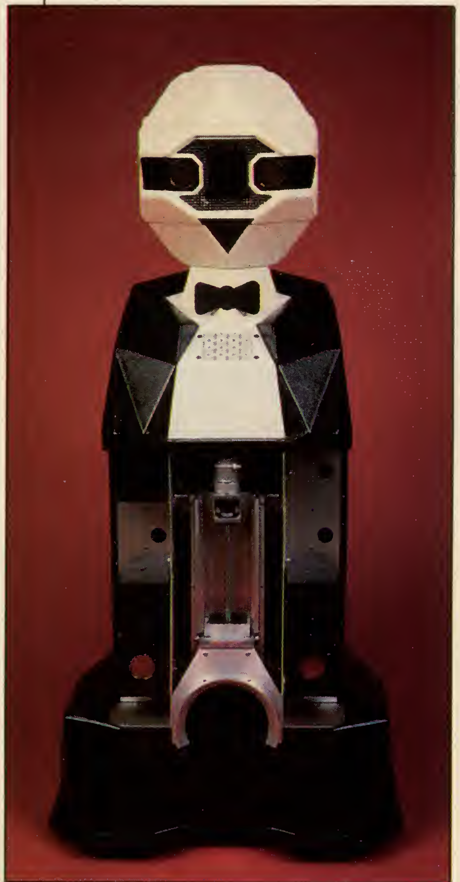
I maneuvered Topo around. I backed him up, spun him to the left and marched him up to Catie's bed. There was a clunk, a loud shriek, then giggling.

Success! I put down the joystick and ran to Catie's room. She wasn't there. Neither was Topo.

There was a crowd in the bathroom. The kids were there giggling. Topo was there looking sleek and happy. My wife Janet was there, too. She didn't look happy. Topo had crashed into the bathroom door, marched in and threatened to climb in the bathtub. Janet wasn't used to bathing with a robot, so she had bonked Topo in the head to turn him off. She threw us all out.

Out in the hall, I analyzed the situation. I had gotten both kids to wake up smiling, but I had a new

ABOVE: Topo loves parties with the D'Ignazio family, but needs help blowing out candles. BELOW: Little "brother" F.R.E.D. can't flashdance like Topo, but can draw.



Topo's big "brother," B.O.B. (Brains On Board), is a smart dresser and the smartest Androbot.

problem: Janet was ready to pulverize me.

ROBOT MUMMY

The way Topo bangs his way around, you'd think he was indestructible. But when he first arrived, he wasn't in tiptop shape.

Topo came in a box big enough for King Kong. Catie, Eric, and I opened the box together and found Topo lying face down in a cushion of plastic foam. He looked like a robotic mummy.

We tried to bring our mummy to life, but couldn't. The manual said an overnight charge would give him enough juice to buzz around the house for hours. But the manual was wrong. We charged him for two days, and all Topo could manage was an electronic burp.

Luckily, we had lots of friendly robot experts at Data Base, a local computer and robot store. The people at Data Base took back our ailing Topo and gave us a new one. Our new Topo has proven to be a trouper. He has run over the cat's tail, smashed into dozens of walls, and been bonked on the head. But he still comes to life each time you pop the green button.

DANCING MACHINE

As I mentioned, Topo is a great flashdancer. My daughter, Catie, also loves to dance. Now Topo has become Catie's favorite dance partner.

Topo will obey a computer joystick, or can be programmed to obey instructions written in TOPO-BASIC or Logo. Catie learned how to program in Logo at camp last summer. With Topo hooked up to the computer, Catie can give him Logo commands like **TFD 50** (**T**opo go **F**orwar**D** 50 units) or **TRT 90** (**T**opo turn **R**igh**T** 90 degrees), and he will dance around.

Catie programs various dance steps into Topo. Then she turns on the stereo and dances with him. She also puts "delay" loops in her Logo procedures to slow Topo down to the beat of the music.

Catie also created several Logo programs to make Topo "take the lead." This was accomplished with the RANDOM primitive, a program command that makes Topo move unpredictably. He becomes a fast, quirky dance partner, and Catie tries to keep up with him. Every so often Catie would add a rotate command—**TRT 360** or **TLT 360**—and she and Topo would spin across the dance floor.

ROOM SERVICE

When Catie and Eric first got Topo they figured they could program him to do chores like taking out the trash, doing the dishes and picking up their rooms.

But as a maid or butler, Topo is a flop. Catie worked for several days writing a Logo program to have Topo pick up her room. He worked perfectly, except that she had to tell him where every dirty sock was and put each sock in his robot hand. Then she had to follow him to the laundry basket take the sock out of his hand, and put it in the basket.

One of Eric's friends programmed Topo to help make Eric's bed, but three-foot-tall Topo was too small to hold the bedspread in his hand. So Eric draped the bedspread on Topo's head. This seemed to work fine until Topo encountered a bug in the program. The bug made Topo pull the bedspread out of Eric's hands, and race out of the bedroom with the bedspread on his head.

Topo was heading for the stairs when Eric caught him and bonked him on the head to shut him off.

After a couple of weeks of living with Topo, my family has stopped trying to make him into a household servant. He just wasn't cut out for the job.

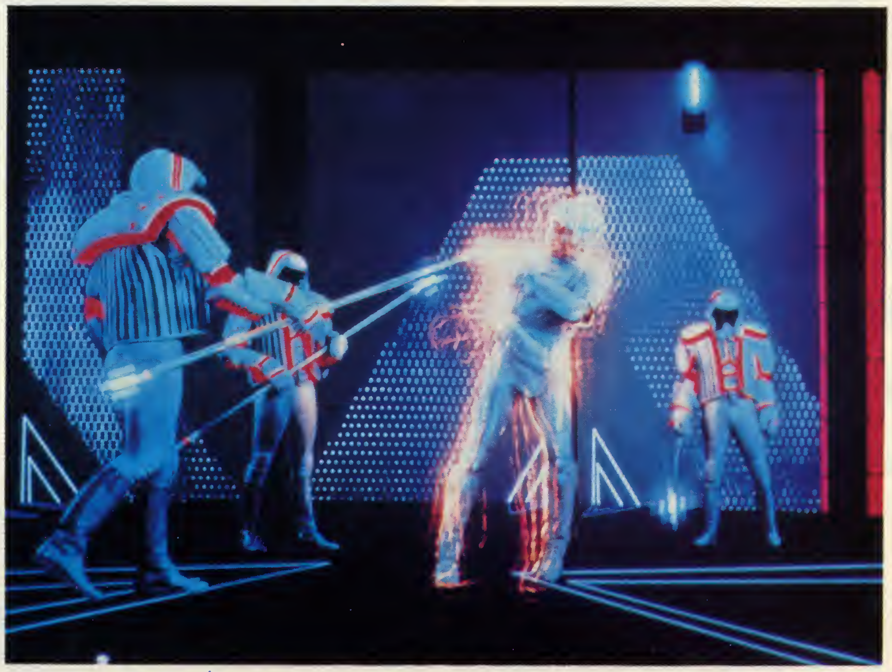
Topo isn't much of a worker. But neither is our fat black cat, Mowie. Yet we've always loved the cat. Now we feel the same way about Topo, even if he is just a machine. He has the makings of a lovable robot.

FRED D'IGNAZIO is an ENTER contributing editor.

THE MAKING OF

TRON

BY FRED D'IGNAZIO



One day, just a few months ago, two men were squeezed inside a cramped trailer on a Walt Disney studio backlot in Burbank, California. They were peering intently at a computer picture screen.

At first the screen was blank. Then glowing, darting images appeared: Giant, horseshoe-shaped flying battleships. Telephone receivers that raced across a fishnet of pure light. Squat, sleek tanks that fired deadly energy bolts.

The inside of the trailer echoed and rocked with the men's impromptu applause, laughter, and sudden arguments. Then silence.

One man scribbled notes on a sheet of paper. The other pushed buttons on a keyboard below the screen. The tanks moved forward, then backward, then forward, all in slow motion. The battleships — alias *Recognizers* — rotated and approached until they loomed on the screen.

The telephones — alias *light cycles* — froze in place on the infinite grid, then inched forward and collided in a burst of blinding light.

What were the men doing? It appeared as if they were playing a sophisticated video game. But they were not playing a game. They were making a movie.

The two men were Jerry Rees and Bill Kroyer, two Disney animators with impressive credits. Both had worked on a number of animated films for Disney and other producers. Rees recently worked on **Pete's Dragon**. Kroyer helped to animate **The Fox and the Hound**.

Now the two were working on **Tron**, the story of a renegade video game designer's heroic battles in a microscopic fantasy world inside a computer.

In the olden days at Disney — the 1930s through the 1950s — animation was tedious and time-consuming. Dozens of animators laboured painting endless sheets of clear plastic *cells* which were later strung together into a feature-length animated film. It became so expensive, in terms of animators' salaries, that high-quality animated films became rare. The field ceased to evolve.

The state-of-the-art films, the classics, were produced nearly half a century ago. Then up popped the computer.

In the mid-1970's, cost-conscious producers began training their animators on computer graphics workstations. The animators used the computer as a *digital paintbrush*.

They drew a film frame on a graphics tablet with an electric pen wired to the computer. Their picture instantly appeared on the computer's TV screen. At the bottom of the screen stretched an electronic palette — a row of twenty or thirty blocks, each a different colour.

To colour his picture, the animator had only to touch the palette with his pen, then lightly tap the screen. In a few seconds, an artist could colour an entire scene.

Animators let the computer do their colouring. They also let it do entire frames. These frames, known as *in-betweeners*, were mid-points in an action scene. For example, if the hero leaped onto his horse, the animator only needed to draw the beginning and ending film frame. The computer could interpolate all the frames in between and draw them itself.

The animators' early programs were known as *paint* programs. The artists still drew most of the film frames, but the computer helped them work faster.

Then computer scientists discovered a way for the computer to *grow* scenes on its own, completely from scratch. A scientist with no artistic ability could feed the computer a mixture of numbers and complex mathematical formulas, and out would come completely synthesized pictures — of craggy mountains, crystal goblets, bowls of fruit, Greek temples, trees, the rings of Saturn, or a pair of unlaced, dirty tennis shoes.

The texture, colour, light, shadows, and perspective in the pictures were realistic and convincing. The pictures looked like photographs. Yet the objects they represented did not exist, except as minute pulses of electricity inside a computer.

In 1977, Steven Lisberger, a talented young director, called on the executives at Walt Disney Productions at their headquarters on Dopey Drive, in Burbank, California. Lisberger had a fabulous movie to propose, and he wanted Disney to produce it.

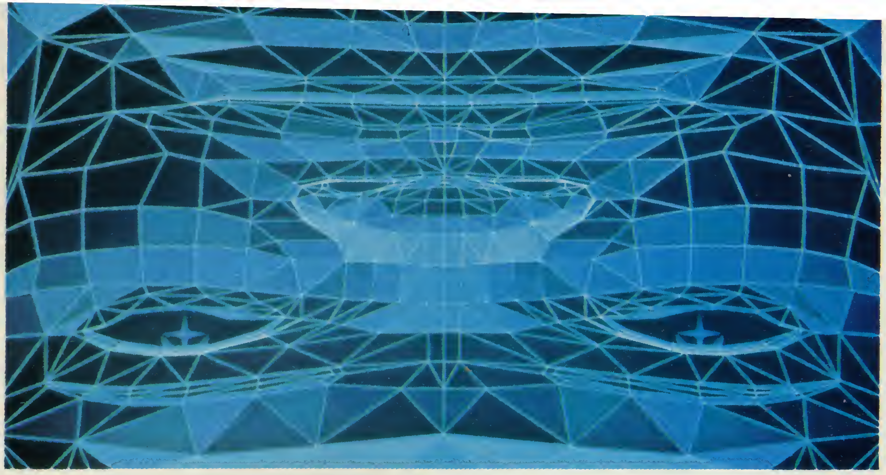
Like fellow director, Steven Spielberg, Lisberger had grown up on magical Disney films like **Snow White**, **Pinocchio**, and **Fantasia**. Now he wanted to bring a little of that magic back to Disney studios where it hadn't been seen for almost fifteen years.

Lisberger had dreamt up a story about Kevin Flynn, a maverick hero who sets out to conquer evil in this world and in a surreal world in the bowels of a supercomputer.

Lisberger's script began with Flynn trying to crack into his old company's computer to locate evidence that his arch-enemy, Dillinger, had swindled him out of several video games he had invented. Bu the computer is controlled by MPC, an ultra-intelligent "Master Control Program".

The MCP is hateful, power-hungry, and utterly without scruples. It catches Flynn at a computer console, zaps him with a laser teleportation device, and sucks him through the TV screen into its electronic domain.

Flynn materializes inside the computer as an electronic being. MCP's brutal guards shove Flynn into a jail cell. Like a gladiator in ancient Rome, Flynn is forced into frequent combat with his fellow captives — programs who re-



sisted MCP and remain loyal to their mythical human *users*.

At the last moment, Flynn discovers an ally: the valiant program, Tron, champion of the human users. Flynn, Tron, and another program, Ram, battle the MCP's warriors on light cycles.

The cycles flash across the game grid leaving multi-coloured energy "walls" in their wake. The walls accumulate forming a maze that the cycles must manoeuvre through and around. The cycles travel at blinding speeds. If a cycle strikes a wall, it explodes and it's rider dies.

Lisberger told Disney executives the story of Flynn and Tron's adventures in the bizarre world ruled by MCP. He described Flynn and Tron's battle to overthrow the MCP, and Flynn's frantic attempt to escape from the computer.

To the conservative executives, Lisberger's film sounded exciting but risky. They were sceptical. They became even more sceptical when Lisberger proposed that the film be completely animated — by computer.

Lisberger's idea was ingenious: He wanted to use computers to create the world inside of the computer.

Lisberger persuaded the executives to let him do a movie pilot. A few months later, the executives saw the pilot, and their doubts turned to amazement, then to enthusiastic support.

When the film finally went into production in 1980, computers and video games had caught up to Lisberger's amazing vision. People all over the world were snapping up home computers and popping billions of coins into computer arcade games.

Also, by 1980, Lisberger had decided not to rely completely on computer animation. He realised that live actors could bring a lot of energy and excitement to the film. He decided that the best combination was a mixture of live action, special effects and animation.

The animation would be done partly by computer and partly by Disney animators. But all of the parts — live action, special effects and animation — had to be blended together into a single film.

The live action in the film was shot in just a few months. The post-production special effects took two years. Of the film's total cost of over $22 million, approximately $6 million went into live-action enhancement. Another $5 million went into computer-generated imagery.

Lisberger wanted the final film to look unique, like something no one had ever seen before. Yet he wanted it to be convincing, believable and real. Live action had to flow invisibly into computer animation. Computer animation had to flow into special effects.

Human animators painted scenes and backdrops that looked as if they were generated by a computer. Film-making computers created characters and effects that looked as if they were painted by humans. Scenes with live actors on barren sound stages were touched up by animators and reflilmed with crimson and blue "backlights" glowing brightly through the actor's costumes, the props and the surrounding geometric landscape.

The result is that the live actors seem to be moving through a computer world created totally by a computer. In fact, out of a total of almost one hundred minutes of film, only 15 minutes are computer generated.

According to Richard Taylor, director of **Tron** special effects:"Creating scenes by computer is like having at your disposal a flawless airbrush artist who can paint thousands of paintings a day with photographic realism, getting perspective and shading absolutely perfect."

But the computer can't work all this magic on it's own. It needs help. Disney animators Bill Kroyer and Jerry Rees gave the computer the cues it needed to generage the images for **Tron**.

Rees and Kroyer's trailer in Burbank high-speed mainframe computer located on the other side of the country, in Elmsford, New York. The computer was run by a team of animators and engineers of the MAGI company, one of four computer-graphics companies that worked on **Tron**.

Back in Burbank, Rees and Kroyer fed the computer with a steady diet of storyboards and scene blueprints. They described every aspect of every frame they wanted the computer to produce.

Rees and Kroyer drew upon all their animation experience at Disney to produce the specifications. Computer operators at MAGI then loaded these specifications into the computer as cold, hard numbers.

The computer ran MAGI's "Synthavision" programs to convert the numbers into speeding light cycles, sinister Recognisers, canyons, bridges and tanks. It created the images out of stacks of 3-D building blocks. The building blocks, known as geometric *primitives* included spheres, cones, cubes and ellipsoids. The primitives were added together, subtracted from each other, shrunk, expanded or distorted to make complex looking objects.

The objects were set into motion and transmitted, via the phone line, back to Rees and Kroyer's trailer in California. The animators watched the scenes in miniature on their computer TV screen.

Elsewhere, other computers were busy cranking out other scenes in the film. At Information International, in Culver City, California, a computer was transforming billions of numbers into the jeweled polygons used to build the beautiful *solar sailer* that carries Tron and Flynn to the MCP's headquarters.

Computers at Robert Abel and Associates in Los Angeles were working on the **Tron** titles and Flynn's thrilling journey from the real world into the circuit world inside the computer.

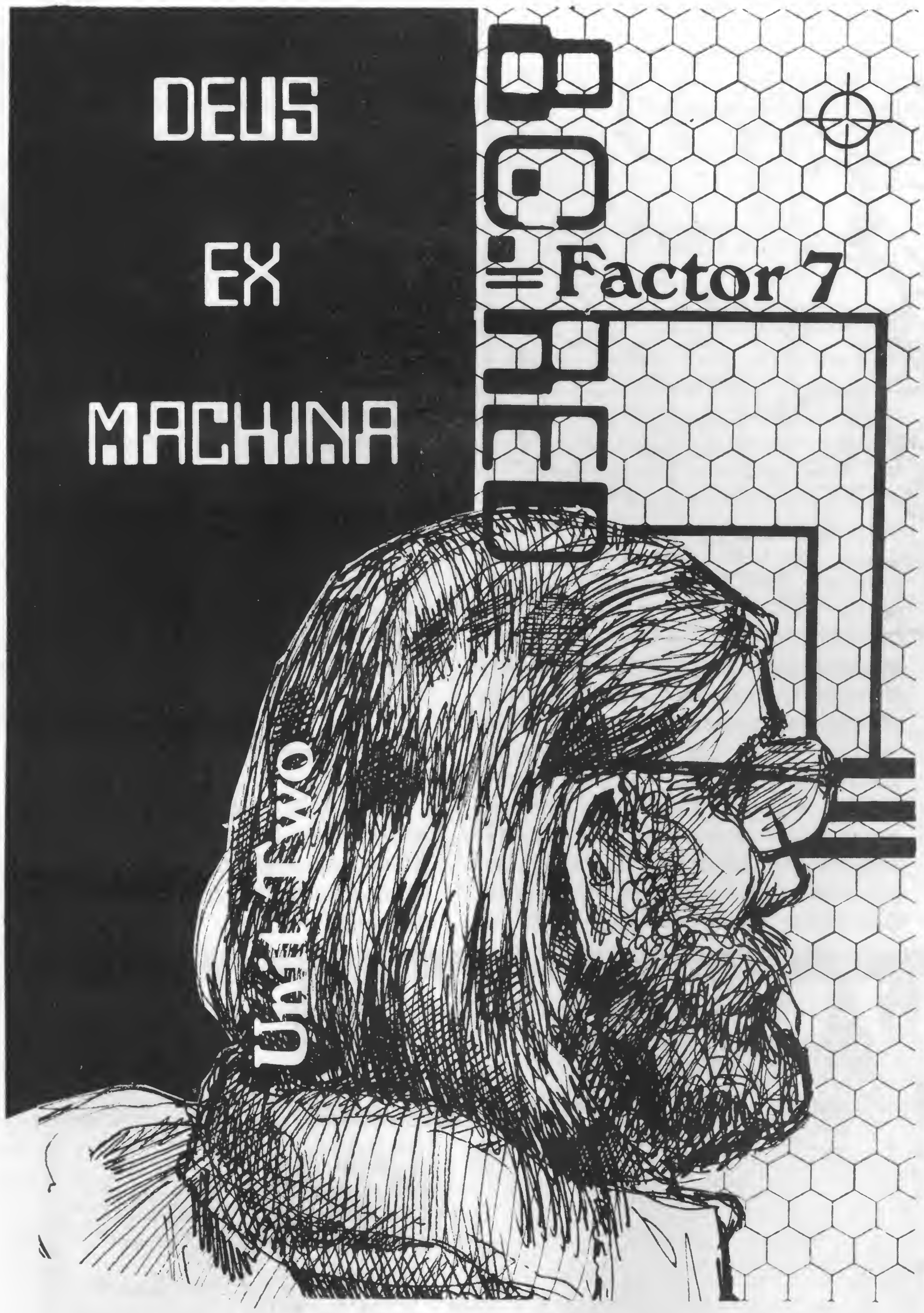
At Digital Effects in New York City, engineers programmed their computer to create one of **Tron's** most memorable characters, a computer *bit*.

The bit could metamorphose it's shape. Sometimes it was a hovering, spiked sphere, other times a floating octahedron. It acted briefly as Flynn's sidekick but could only supply two answers: yes or no.

In the U.S. the film was first released on July 9. Critics of the movie surfaced immediately, decrying it's shallow, comicbook characters, it's weak plot and it's overuse of special effects. According to one reviewer: "Walt Disney never forgot the importance of plot and of making the audience care about the characters. Lisberger has a great deal of talent, but **Tron** would have profited from remembering such basics."

The critic's observation is apt. **Tron** frequently gets lost in its own wizardry.

Perhaps the best way to look at **Tron** is as the grandaddy of a new generation of movies. **Tron** is the first, bold step to a new era in which computers and humans together produce films more magical than anything we've ever seen.



Game in the Computer/ Computer in the Game

by Fred D'Ignazio and Allen L. Wold

The typical computer game contains the whole game in the computer program. As in *Adventure*, that is all there is to it. No matter how intricate the puzzle, how thrilling the graphics, what you run is what you get.

Adventure is an interesting computer game. Yet it is a game that is closed and finite. Everything you need to play is there inside the computer once you run the program. You don't have to add anything to the game except decisions. There is nowhere else to go than Colossal Cave, and nothing to do but solve the puzzles, find the treasures, and get them out.

On the other hand, role-playing games are unique and open-ended. *Dungeons & Dragons*, on which *Adventure* is loosely based, is open and limitless. The players must add a great deal to the game, including maps, characters, objectives, verbal descriptions, and decisions. At the same time, the rules are such that if you want to do something else, you can. You can leave the dungeon, go to a town, have a party, get a job, or whatever.

Yet how many times have you played role-playing games and wished the tables and charts weren't so complicated that most of your time was spent interpreting them? The typical RPG offers lots to do, but the play is impeded by pages of rules, most of which deal with reading and evaluating the numberous tables.

The Programmed DM

Fortunately, a new group of electronic games are searching for a new, middle way between the closed, finite computer games and the open, limitless role-playing games. This new, middle way tries to eliminate the weaknesses and preserve the strengths of these two earlier types of games.

We can see the beginnings of this middle way in games such as Mattel's *Electronic Dungeons & Dragons*, Magnavox's *Quest for the Rings*, Ideal's *The Generals* and Milton Bradley's *Dark Tower*. All these games differ from *Adventure* in that they have a computer embedded in the game, instead of a game embedded in the computer.

But these games are just the beginning. And there is also a problem: The game designers are trying to capture a role-playing game and transfer it to a computerized game piece or game board. The computer is miniature and hidden inside the game. But the computer is still there, and this alters the game. It is no longer open and infinite. As in *Adventure*, it has become finite and closed.

Another middle way that is being explored appears in the *Wizardry* game created by Andrew Greenberg and Robert Woodhead of Sir-Tech Software Inc. *Wizardry* would be a marvelous game even if it were completely finite and closed. Yet it is not. The characters you create and build up during the game can be saved, resaved, replayed, and transferred to new games and new adventures. The characters achieve a life of their own outside of the individual games and outside the finite game program running inside the computer. And the finite adventures described in each program become *episodes* in a larger, grander adventure that (hypothetically, at least) is limitless.

The electronic board games and games such as *Wizardry* represent two extreme but interesting new ways of combining computers with role-playing games. But

both types of games are produced by professional game designers with considerable technical and financial resources. The methods they employ are out of reach of the average computer hobbyist or role-playing game enthusiast.

The Programmer DM

Yet there is another way — a technique for using computers to aid but not limit an open role-playing game. This way will give the serious game player the advantage of computer-assisted play and the open-ended nature of a role-playing game. And it is a method that can be employed by the average computer hobbyist or role-playing game enthusiast who has access to a microcomputer.

To take this third, "middle" way, we need to divide the role-playing game into two parts. The first part includes the decision-making and piece-moving aspects of the game. The second part includes the comparison of pieces, the reference to tables, and creation of the element of chance in the game.

If there is a board in a particular game, leave the board. A 2-foot-by-3-foot, four-color map board and three-dimensional pieces provide a great amount of visual and tactile satisfaction. The computerized "light" pens and the colorful, animated picture-screen graphics that enhance the newer computer adventure games will soon replace these boards . . . but not yet.

Also, don't take away the human game master and replace him with a computer program — a crude electronic facsimile of an imaginative and crafty human being. The computer can not compare with a good human-moderated game in which the game master has spent days — even weeks — creating an adventure to challenge the game's human players. At his fingertips, the well-prepared game master has gathered stacks of books, hundreds of charts, piles of maps, and heaps of dice.

So keep the game master. But free him from his trivial, distracting chores. Free him from all his scorekeeping and bookkeeping. Put all the tables and charts into the computer. Let *it* roll the dice, check the right columns, modify the rolls, and give the results. The computer will give the answers instantly, the answers will be correct every time, and the game master will be freed from an exacting, tremendously time-consuming chore. He will be free to make the adventure more lively, more inventive, more perilous, and more rewarding for the other players.

How is this computer-assisted role-playing game actually set up and played? It begins days or weeks before the actual game, when the game master writes a set of programs — a world generator, a world reader, and a character generator. Using a world generator program, he can create the fantasy or science-fiction universe he plans to use in the game. Using the world reader, he can save that world on a tape cassette or diskette. And, using the character generator, he can create a rich set of NPCs to populate his game.

When the human players arrive to play the game, they will find the game master armed with only a hex paper map, colored pencils, and his computer. The players may also have maps and pencils. But everyone's rule books, reference books, tables, etc. can either be discarded or significantly reduced. Now the computer manages all these functions.

As a result, the computer has taken all the drudgery out of playing and moderating the game. When the game master needs a new treasure or a new monster, he can get one instantly, at the push of a button. When combat is conducted, the computer can supply the most elaborate conditions, then report the most complex results, instantly. Both the players and the moderator are left with only the game to think about, not its mechanics.

The DM's Program

This sounds like a dream. Yet it has already been done. For example, see Chris Marvel's excellent article, "Traveller in Your Computer" (*Creative Computing*, November, 1981). *[Also, a program is available on disk from FASA — FJ.]*

Chris is an experienced programmer. Chris's program is ambitious and comprehensive. But your program doesn't have to be. If you are a role-playing game enthusiast but only a novice with computers, don't worry. Your tables and programs can be simple at first — mere skeletons or outlines. Later, you can enrich them, add to them, and make them more complex.

We know this is possible. The non-computer half of our own team (Allen) has already put together a primitive program along the lines we outlined above. It is not what could be done by an expert, but it is a start.

Remember that the programs you write don't have to replace the moderator, just *help* him. They supplement his intelligence and memory in the same way as books, tables and dice. But they are much faster and easier for him to use while he is moderating the game. Best of all, when the game master uses them, he can stop worrying about keeping his thumb in the right place.

HIGH-TECH REPORT: Robotics

In a recent mission,
Argo, an undersea robot camera system,
took this photograph of the Titanic, the famous ocean liner which sank in 1912.

COURTESY OF W.H.O.I.

By Fred D'Ignazio

Close your eyes for a moment and imagine your toy GoBots coming to life. Think of it: Guardian GoBots like Dive-Dive, Spay-C, and Turbo changing into real-life robots. You could command them to take you on a journey to search for other robots.

In the past, real robots were only found in dreams, movies, and comic books. But now they are here—under the oceans, in outer space, in factories and classrooms, and even in some homes.

Real robots can be any shape, just like GoBots. But real robots can't convert into other forms the way your GoBots do. Not yet, anyway. Once they are built, they usually stay the same shape forever.

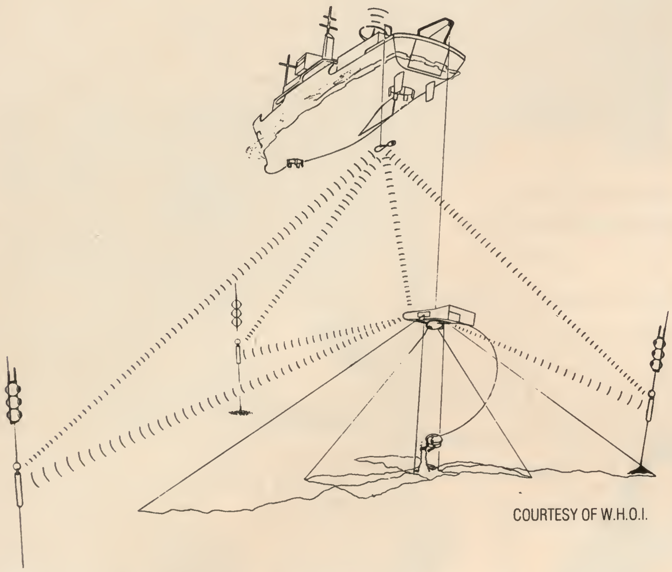
There are three clues you can use to identify a real robot. One: A robot has a computer for a brain—usually a tiny microchip computer the size of a cornflake with lots of tiny wires, each one thinner than a human hair. Two: A robot has sensors. Sensors, like microchips, run on electricity. They let a robot see and hear, almost like a person. Three: A robot stores people's commands in its computer memory, then follows them, one at a time. This makes a robot seem alive, but it's not really alive—it's a machine. And it can only do what someone has programmed it to do.

Undersea Robots

Dive-Dive takes you on the first leg of your journey. The first real robot you find is floating deep under the Atlantic Ocean. It's called Argo, and it's named after a ship in Greek mythology. Argo looks like a beach ball with propellers. It has a long cable stretching up to a scientist's ship that bobs around on the surface of the water. Argo is a waterproof detective and explorer robot. It can go deeper under the sea than any human, and it can stay underwater longer, too.

What is Argo looking for? Scientists command Argo to turn on its blinding white searchlights and its TV

camera. Then, in the cabin of their boat, the scientists can watch a TV picture of what the robot sees on the floor of the ocean. It could be a sunken ship or maybe some strange deep-sea creature no human has ever seen before.


COURTESY OF W.H.O.I.

This sketch shows Argo attached to a small ship. The specially equipped robot is able to locate large objects miles below the surface of the ocean and send photographs and other data back to scientists onboard the ship.

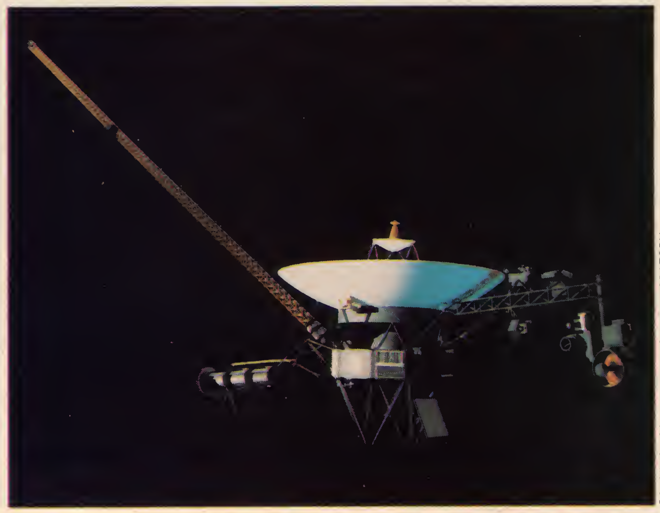
Argo has a baby robot-mate named Jason—after a sailor aboard the Argo in the Greek myth. Jason can swim out from Argo and go right down to the bottom of the ocean to take a close-up look at whatever the scientists are investigating.

Robots in Space

You meet up with Spay-C next, and blast straight up into outer space. Far off in deep space, past Mars, Jupiter, and Saturn, you spot a new robot named Voyager. Voyager is a robot spaceship on a mission to explore our solar system. It has already taken TV pictures of the inner planets near the sun. Now it's headed to distant, cold planets—the giants Uranus and Neptune.

Spay-C changes course and heads back toward Jupiter. There you discover a robot spaceship named after the famous Italian scientist Galileo. Galileo is flying around Jupiter, taking pictures of its boiling, hurricane-filled atmosphere. Galileo also turns cameras on Europa, Ganymede, and Callisto—moons of Jupiter.

Like Argo, Galileo has a "baby" robot known as a probe. The probe robot can leave Galileo and dive down into Jupiter's windy atmosphere to take pictures


COURTESY OF JET PROPULSION LABORATORY

Voyager, a robotic spacecraft, is now heading for the planet Uranus and sending scientific data to earth. The yellow boom on the left of this model is actually 43 feet long!

and perform experiments for scientists.

The Galileo and its probe have stored in their memories the commands given to them on earth by scientists. They also have millions of new facts about Jupiter, gathered with their telescopes, cameras, radar, and other sensors, stored there. They send this information back to Earth via radio waves that travel at the speed of light.

There are other robots in outer space. When you fly back toward Earth, you see a tiny white spaceship zipping beneath you. It's the Space Shuttle, and stretching like a crane out of its back is a giant robot arm. The shuttle has a huge cargo hold. The robot arm picks up new satellites out of the hold and places them gently in outer space. And it rescues damaged satellites from space so that astronauts can repair them.


COURTESY OF UNIMATION, INC., A SUBSIDIARY OF WESTINGHOUSE ELECTRIC CORP.

Factory robots do the dangerous work. Here, robot arms weld the bodies of new cars in an auto factory.

Robot Dinosaurs?

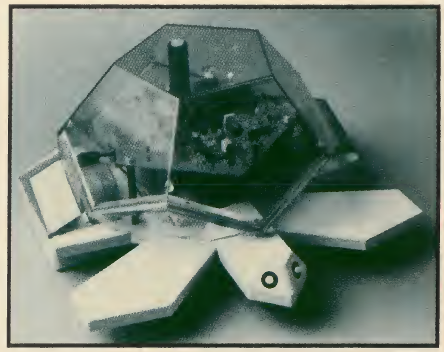
You return to Earth where Turbo speeds you up to the gleaming doors of an automobile factory in Dearborn, Michigan. For a moment, you think you're seeing dinosaurs! Then you laugh, realizing your mistake. The "dinosaurs" are really robot arms like the Space Shuttle arm. They are welding and spray painting cars, moving heavy crates, and dipping car engines into molten metal. They're doing what factory owners call "3-D jobs"—jobs that are Dull, Dirty, and too Dangerous for human beings. There are also robot carts, robot stackers, and a robot foreman scattered around the factory.

Next stop: San Francisco, California. Turbo drives you to a Robot Congress where hundreds of people gather to see the latest robot creations on display. There's a robot that plays Ping-Pong, a robot arm for disabled people, a robot wheelchair, and even a robot that talks with you.

Sensors and computer power make this home robot—which takes about 100 hours to build—move around all by itself.

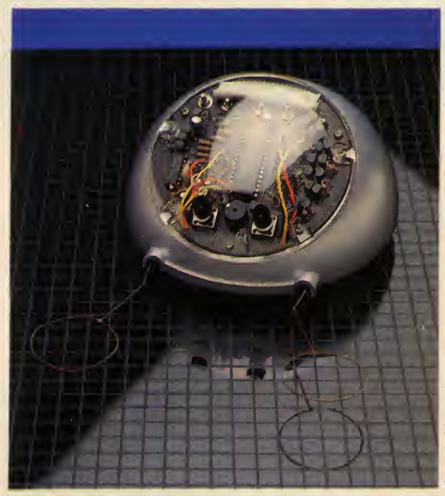
COURTESY OF HEATH COMPANY

Before you can say Robbie the Robot, Turbo's driven you to another robot site, a little boy's bedroom. You watch as he types commands on a computer keyboard, causing a green turtle-shaped robot named Valiant to roll on the floor and draw circles, squares, flowers, and faces.



COURTESY OF HARVARD ASSOCIATES

You can make Valiant, this robot turtle, draw by using a computer to give it commands.



COURTESY OF OWI

Movit robot toys act almost like pets, responding to sound and touch, and moving around on tiny wheels.

In the same room, there are also two home-built robots which the boy has put together with help from his dad. One is a Movit, a clear plastic robot that responds to voice commands or objects it touches. The other's called Herojr. This robot has enough computer power and sensors to move around the boy's house all by itself.

Now Turbo takes you home and changes back into a toy. Too bad GoBots can't *actually* become real robot cars, submarines, and spaceships. Who knows? Maybe you'll be the one to invent robots that *can* do those things. Now *that* would be neat!

The World Inside The Computer

S. Frederick D'Ignazio

Stan Gilliam (left) and Fred D'Ignazio (right) watch Fred's four-year-old daughter, Catie, type messages to *Ged,* the family's home computer. (Photo by Harold Moore, *Durham Morning Herald.*)

> *. . . if you can program your computer, here is a tiny universe in which you can be God. Within the realms of expression that the computer can provide, you can build a world, define its laws, and watch the universe unfold. As your whim dictates, you can intervene at any time and, if you desire, the history of your universe can be changed or rewritten at will. Such a paper this is!**

Kids use personal computers to play games. What are these games? Often, they are *simulations* or *models.* In creating computer games, kids are learning to build miniature replicas of the universe — models of the real world and worlds of fantasy woven from the threads of pure imagination. As personal-computer technology evolves, and as the child becomes a more knowledgeable and sophisticated model-builder, his or her models will become increasingly lifelife, dramatic and enchanting. Volcanoes will roar, thunder and belch black plumes of ash and smoke. Fire-breathing dragons will appear unexpectedly along dark and slimy, maze-like corridors. Heroes and heroines will arrive on the scene, accompanied by the child's personally composed epic music.

Consider for a moment, the youngest children — the preschoolers and the primary-school kids. These children are to be envied. Their inquisitive minds, their natural inventiveness, and their unbridled imaginations are perfectly suited for the personal-computer devices — "the mind tools" — that lie just around the corner.

*Gregory Yob, "The Computer as a Gun: Personal Computers and Personal Autonomy," *NCC '79 Personal Computing Proceedings,* New York: American Federation of Information Processing Societies (AFIPS), p.9, 1979.

S. Frederick D'Ignazio, 730 Williams Circle, Chapel Hill, NC 27514.

The question arises: "How should we introduce the computer to these kids?" Certainly we should abandon the approach followed in the past. At that time computers were often pictured as rows of boxes connected by skinny lines and arrows. To the young child the computer was a curious hodgepodge of *memory* boxes, *processor* boxes, *input* boxes, and *output* boxes.

As the child becomes a more knowledgeable and sophisticated model-builder, his or her models will become increasingly lifelike, dramatic and enchanting.

Then, with theory out of the way, the child was shown pictures of a real computer: stark, black-and-white photographs of hulking, whooshing tape drives, squat card readers laden with stacks of punch cards, and huge switchboard panels teeming with tiny blinking lights. And who did the child see working with these machines? Solemn, silent people servicing the machines, feeding them and communicating with them. Everyone was well-dressed. It was a lot like church.

Obviously, a new approach is needed to introduce the new, personal computers to the youngest children. Of course, within only a few years, this will cease to be an issue at all. Then, home computers will be so common, that even the youngest child will first learn about computers by watching his or her mom and dad or older brother or sister. Shortly after, she, too, will be talking and listening to the computer, making it play musical tones, and painting pretty pictures on the computer screen with her light "brush."

But for now, an alternative approach is needed. One method has been recently tried and been proven effective, and I'd like to briefly describe it to you. This method consists of introducing computers to young children using my picturebook, *Katie and the Computer.* The book is a fantasy adventure story, but one with an important twist: each episode in the story parallels the functions of a real computer as it processes a real program. The program itself isn't an "adult" program, producing business-like and adult results. Instead it is a *FLOWER* program that produces something interesting for the child: a pretty picture and an attention-grabbing sound.

Introducing computers to children via an adventure story accomplishes many objectives. First, it captures children's

interest. And, in becoming interested, the children identify with and become personally involved with the adventures of the heroine in the story as she journeys through the computer. Second, it establishes an important connection between computers and drama, color, imagination, action and excitement. And last, unobtrusively, yet deeply and effectively, the adventure story familiarizes the child with the key words associated with computer components and with the major processes occurring within a computer. The components are metaphorically realized as landmarks in *Cybernia,* the world inside the computer. The processes appear as episodes in the story.

Kids, Meet Katie And The Computer!

Katie's father was waiting for her when she got out of school. He was very excited. "Katie," he said, "our computer came!"

"Oh, boy!" said Katie. "Can I play with it?"

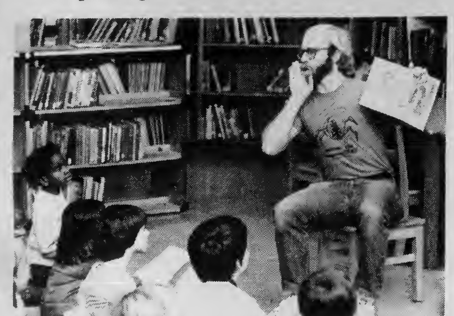
"Sure," said her father, and they rushed home.

Katie and her dad arrive home. Her dad types the word, "PARROT," on the computer, and a bright green parrot appears on the screen and says, "SQUAWWK!"

Katie wants to make something, too. Her father has her type the word, "FLOWER," to make a picture of a flower.

As Katie typed "flower," she leaned closer and closer and closer to the picture screen. Then she lost her balance and fell forward. But instead of bumping her nose on the glass, she went right through it and began spinning and falling, just as if she'd tumbled off the top of a tall mountain.

So begins Katie's adventure with her magical computer. On her whirlwind trip through the world of *Cybernia* inside the computer, Katie bobsleds down the vertical face of a mountain, parachutes from an airplane, slides down a slippery brass pole, gets fired from a cannon, and



Fred tells the story of *Katie and the Computer* to children at the Estes Elementary School in Chapel Hill, North Carolina. Here he plays the part of the software Colonel as he, Katie and the Flower Bytes bobsled down a snow-covered mountain inside the computer. "Let's go now!" hollers the Colonel. "We're overdue at the CPU!" (Photo: Danny Moore, *Chapel Hill Newspaper.)*

The Origin Of Katie & The Computer

Catie's nose banged into the computer picture screen. "WAAHHH!" she howled.

I leaned forward, grabbed her under the arms, and took her into the kitchen to her mother. "She's done it again," I complained. "Bounced forward on my lap, right into the computer. She keeps this up, and she's going to break her nose on the screen."

"Or maybe go right through," my wife mused.

"Go right through!? And get tangled up in wires or get a blast from a hot cathode?"

"Not at all," Janet said, smiling. She wiped away our daughter's tears. "Catie wouldn't find wires or cathodes. She'd find adventure and zany characters, just like Alice did when she fell down the rabbit hole into Wonderland. Only this wouldn't just be a "land," it would be a whole world, a world inside the computer."

Janet loves children's books. It was just like her, taking something complicated and technical, like a computer, and turning it into a fairy tale. "But once Catie fell into the computer, how would she get out?" I asked.

"You're so anxious to write a children's book," Janet said. "Here's your chance. Write about Catie's adventures in the world inside the computer, and use those adventures to teach little kids how a computer really works."

"But I still don't know how she gets out," I said. I imagined a bizarre scene in which Janet and I used cranes and pulleys to rescue two-year-old Catie from the electronic bowels of the computer.

"You'll think of something," she said.

And she was right. We were on the interstate just outside South Hill, Virginia, in the middle of a long trip back from Pennsylvania. Caught between the monotonous boredom of the road and hyped up on coffee, I began seeing an animated cartoon of "Catie and the Computer" right inside my head.

I pulled off the road and drove up to a Pizza Hut. "I'm starving," I said. "And, besides, I've got to write this down."

Without explaining, I hopped out of the car and dashed into the restaurant. When Janet and Catie walked in, a moment later, I had already accumulated a stack of paper napkins, and I was busily scribbling — blotting blue marker and tearing the paper, but capturing the story as it flowed from my brain.

When we left the restaurant, I carried my precious napkins with me in a tight little wad. We finished our drive back home to Chapel Hill. The next day I called my friend Stan Gilliam, a local artist. Stan and I had gotten together several times trying to figure out a kid's picturebook we might collaborate on. "I think I've got an idea," I told Stan. I rushed out to his place, a tiny log cabin, nestled against a forested hillside south of town.

When I got to Stan's I began telling him the story. I stood up, paced around the room, and gestured wildly as I talked. We both became excited. Stan reached for his drawing pad. Swiftly, nimbly, he began sketching scenes from the book as I described them. "Here's the Colonel," he said, "and Catie, and the mean and awful Bug."

I had never worked with an artist before. I couldn't believe my eyes. It was like magic. My words were being turned into pictures, even as I talked. This is going to work, I thought. We've got ourselves a book!

Well, not quite. First, I had to write the words down. (Up until then, all I had were scribbled notes on an untidy stack of Pizza Hut napkins.) Second, Stan and I began endlessly revising the pictures and the words, to get them to work together harmoniously and dramatically.

We attended an evening course on children's literature and presented our story to the class on its final meeting. I told the story in spite of a bad case of laryngitis. And a sudden downpour threatened to wash away Stan's watercolor illustrations as he pulled them out of the trunk of his car and made a frantic dash to our instructor's front porch.

While we revised our words and pictures and attended our course, Stan and I conducted a literature search for other children's picturebooks about computers. After an exhaustive search, we only managed to turn up two titles in over ten years, and both books were completely different from ours.

We began sending our proposals: to ten publishers, twenty, forty, eighty, a hundred. Finally, almost a year after the fateful visit to the South Hill Pizza Hut, and after three false starts with other publishers, we sold our book to *Creative Computing.*

Now the real work began. Stan started turning out page after page of original, full-color illustrations. Meanwhile, with guidance and help from Burchenal Green, our editor at *Creative,* I revised my manuscript another dozen times. I cut out the story's voluminous descriptive passages and relied on Stan's pictures to visually convey each scene. I had to throw out most of my big words in order to make it possible for a second or third grader to read the book herself. And there was the balance to strike between the book's two main goals: *entertainment* and *education.* I had to walk a swaying tightrope and make the episodes metaphorically parallel the functions of a real computer yet keep them action-oriented, dramatic and exciting.

World, cont'd...

comes face to face with a monster robot spider.

She also meets a variety of characters in Cybernia. There's a fiery *Colonel,* "a curious-looking man in a fancy soldier's uniform." There are the *Flower Bytes,* each with a letter from "flower" painted on his or her uniform. There is the *Table Manager,* "a frail, frazzled looking man with fists full of paper scraps." There are the *Flower Painters* "who grab buckets of gleaming paint" and who "move like whirlwinds." And there is the "mean and tricky" program *Bug,* perhaps the most memorable character of them all.

What does Katie do inside the computer? She tries to get the computer to paint a picture of a flower. Is she successful? Does the flower get painted? Does Katie escape from Cybernia and return to the real world?

Over four thousand children have "met" Katie and the computer, and have heard me tell the story through to its climactic conslusion. The kids' ages range from 3 to 11. I've told the story at a day care and at a dozen elementary schools. Over time I've developed three different approaches to telling the story, depending upon the age or grade-level of the children.

Finally, the story and illustrations were ready. At the last minute, we changed the name of our herone from "Catie" to "Katie," to avoid mispronunciation. We persuaded our editor, Ms. Green, to retain the story's villain, the Bug, who we felt, though scary and evil, was a dramatic highpoint of the book, and still (on many occasions) metaphorically accurate. We suffered through endless delays with the book's printer and binder. But the book was finally ready. On December 20, 1979, on Catie's fourth birthday, she and I drove up to New York City and jointly autographed the first copy of *Katie and the Computer.*

Stan and Fred reading their picturebook, *Katie and the Computer,* to children at the R.N. Harris Elementary School in Durham, North Carolina. When they appear together, Fred usually tells the story and talks about computers, while Stan describes some of the techniques he used to create the book's lively, full-color illustrations. (Photo courtesy of the *Durham Sun.*)

Inside The Computer It Was Snowing

With the youngest kids (the kids at the day care and the five- and six-year-olds), I concentrate on the story as an *adventure* rather than as a *technological metaphor.* I

Who did the child see working with these machines? Solemn, silent people servicing them. It was a lot like church.

tell the story on my feet, acting out the parts and adopting voices for each of the characters. For example, when the Table Manager talks, he has a quivering, squeaky falsetto. But when the huge and horrible Bug appears, my voice deepens into a gravelly, threatening roar.

As I talk, I pace back and forth in front of the kids, waving my arms, leaning from side to side. I try to dramatize each of the story's major episodes. In one episode, the Colonel smacks the Table Manager with the flat part of his sword to get the Table Manager's attention. In expressive pantomime, my arm and my imaginary sword arc high in the air, then swoop down. My hand loudly slaps the back cover of the book, giving the Table Manager a resounding "SMACK!" on the bottom.

Later in the story, Katie and the Flower Painters hop aboard a Cybernian Bus and leave RAM Tower, the Flower Painters' home. Just as the bus begins rolling, the Colonel arrives and makes a giant leap onto the bus' tail end. Playing the part of the Colonel, I back up, then run forward and jump high into the air. I close my eyes and make believe I'm Mikhail Baryshnikov hurtling gracefully across an opera stage. But like the Colonel landing on the bus, I come crashing down onto the schoolroom floor, puff noisily and holler, "Head to the CPU, then on to the Tube for some fireworks!"

As I'm telling the story, I punctuate it with numerous sound effects, just like those in the book. Katie lands "FLUMPFF!!" in a bank of feathery snow. The Flower Bytes' bobsled pulls up in front of the CPU with a "SHHHUUUUPPP!" And the cannons roar "BOOOM!! BAROOOM!! BOOOM!!" as they "belch colorful clouds of fire and smoke into the night-time sky."

Also, I try to get the children to participate in the story as much as possible. For example, I point to illustrations in the book, and have the kids call out: "R-O-M!!" "C-P-U!!" and "R-A-M!!" As Katie races through her adventures, I have the kids constantly spelling out "flower." And when I reach the part of the story where the Flower Bytes line up in the CPU and call out their letters to the Table Manager, I get six eager volunteers to stand up, stick out their chests, hold their heads high, and yell out their letters: "F!" "L!" "O!" "W!" "E!" "R!"

At the end of the story (which takes around twenty minutes to tell), I pop out of the fantasy and remind the children that Katie's computer wasn't real, it was magic. But I make it clear that real computers are *almost* magic. I tell the kids about integrated circuits that keep getting smaller and smaller. I talk about whole computers that fit inside a paper clip, million-byte bubble memories smaller than a kid's thumbnail. I talk about the computer's amazing speed — how it can do thousands, millions and someday billions of things in a single second. Then I answer the kids' questions and make sure to get the kids talking about what computers mean to *them.*

The parts of the book that I use with this youngest group are the story itself, of course, and the magnified image of the computer chip that appears at the end of the book. Also, I tell the kids that a real computer doesn't have little people running about; that, instead, the computer is powered by tiny bursts of electricity zipping about at a fantastic speed. I show

the kids the page that says, "MEET THE FLOWER BYTES." Pointing to the Flower Bytes, I tell the kids that each byte is made up of charges of electricity, whizzing single file along the computer's wires. I remind the kids how the bytes themselves, all in a row, bobsledded down the mountain to the CPU.

Half Magic

The next group of kids are the seven- and eight-year-olds, kids who are in the second and third grade. From experience, I've learned that the book's fact and fantasy mix together just right for these kids. They're at the tail end of the picturebook age, and they still have a great appreciation for magic and fantasy. Yet they are old enough to understand the computer concepts introduced in the book.

I enjoy telling this group about some of the applications for small computers, including robots, computer music and computer "paintbrushes." We talk about such things as computer *animations, movies* and *cartoons.* I ask the kids what kinds of movies and cartoons they might create, what kinds of sound effects they might use. We talk about composing theme music and creating computer graphics for computer games, and about animating characters on the video "stage." On occasion, Stan has appeared and enriched this discussion with the ideas and techniques he used to illustrate *Katie and the Computer.*

With this group, too, I begin by telling the story, complete with characters' voices,

Fred telling the story of *Katie and the Computer* to kids at the Victory Village Day Care in Chapel Hill, North Carolina. Katie, the Colonel and the Flower Bytes have just entered the CPU and are trying to locate the address of the Flower Painters who live in RAM Tower. Playing the part of the Colonel, Fred smacks the address Table Manager on the bottom with the flat part of the sword to get his attention. (Photo by Chip Hoover.)

bounds, leaps and frantic arm waving. Also, I often bring along a small computer, like a *PET* or an *Apple II.* After I tell the story, I open the computer up to show the kids the electronics inside. But there is a problem. The element of fantasy becomes so real for these kids, that when they crowd around the computer, they want to know where the characters from the story are — *especially the Bug!* "Let's see the robot spider!" they cry. "Where does he live?"

So I've developed a response, a way to make a clean break between the real and fantasy sides of the book. Now, as soon as I've read the story, I walk over to a table and grab a chair. "You have just heard a story about Katie's magic computer," I begin. "If you want to see a real computer, go to a shopping mall and visit a Radio Shack. Radio Shack stores have a computer known as the TRS-80.

"Let's pretend that I'm in a Radio Shack right now." I point to an empty spot right in front of the chair. "Let's say I've just entered a Radio Shack and walked over to a TRS-80 computer sitting in front of this chair. Say I've read the story of *Katie and the Computer,* and I want to be

One of the most popular parts of the presentation deals with computer-controlled robots. Kids love them!

like Katie and somehow get into Cybernia, the magic world inside the computer.

"I look all around. I want to be sure no one is watching. Good. The coast is clear. Real quietly, I step up onto the chair. Then, before anyone can stop me, I fold my hands together, and, like the Table Manager in the book, I dive like an eagle — right into the TRS-80 computer!"

In the classroom or library, with the kids' mouths wide open and the teachers looking amused or perplexed, I crouch down low on the chair, then spring high into the air, and come crashing to the floor with a loud "THUMMPP!!"

I run over to the kids, eyes squinting, a serious look on my face, and ask, "If I really did dive into a computer, would I r-e-a-l-l-y fall inside, just like Katie?"

Usually, I've looked so absurd and ridiculous that the kids' sense of realism takes over, and they all cry, "Noooooo!"

"What would *really* happen?" I ask.

"You'd crash into the glass!"

"You'd break the computer!"

"You'd get all tangled up in the wires!"

One third grader, blessed with a vivid imagination, had a more elaborate answer: "You'd fall into the computer, but you'd blow up and be splattered all over and be all around. And then you'd be electrocuted!"

Fred tells Katie's story again at Victory Village. He plays the part of the Colonel, and the kids pretend to be Flower Bytes. (Photo by Chip Hoover.)

After that one, I had little worry about some gullible kid trying to mimic Katie and jump inside a real computer. At least I knew *I'd* never try it.

Binary Numbers, Adventure Games and Robots

When I tell the story, the most charming kids are the ones in the first two groups. They get thoroughly wrapped up in the fantasy, yet, with a little prompting, they easily make the leap back to the world of real computers.

When I talk to the third group, the kids nine years old and older, things are different. These kids are past the picture-book age, and they look at picturebooks as babyish and beneath them. Also, they're more skeptical than the younger kids and more likely to resist the strong element of fantasy in the story.

The real pleasure I get with the older kids comes after the story is finished. Then I can use the entire book as it is meant to be used: as a teaching aid. I use the factual section at the end of the book to teach the kids about computer *hardware* and *software.* I use the "Pictorial Outline" in the front of the book to show the kids how a real computer would process a "FLOWER" program and display a color image of a flower on the picture screen. And I teach the kids about *binary numbers* and *computer translation* with a scene where the computer's operating system, pictured as the blustery, imperious Colonel, summons the Flower Bytes:

"This is where the Bytes live," the Colonel said. "Each Byte has a letter or number that's all his own." The Colonel reached for his bugle. "I use this to summon the Flower Bytes," he explained. "It only plays two notes, but I

World, cont'd...

can arrange them into a special song for each Byte. Listen, and you'll see."

"BLEEETT!" burped the bugle. "BLAATT! BLEEETT! BLEEETT! BLEEETT! BLAATT! BLAATT! BLEEETT!"

I flip to the page called "MEET THE FLOWER BYTES." As the book does, I tell the kids about high and low electric charges and how a "BLATT!" from the Colonel's bugle means a high charge or a *one,* and a "BLEEETT!! means a low charge or a *zero.* I stand at attention, like the Colonel, and begin loudly blowing my imaginary bugle. I play a special song for each Flower Byte. At the end of each song, I get the kids to use the *ASCII* table in the book (illustrated with cartoon pictures of each Byte), and tell me which Byte's song I just played.

I especially like telling the older kids about *adventure* games. We get into a discussion of model-building and simulation — of real worlds and worlds of fantasy. When I have time, I mix computers and creative writing. First, I have each child write up the script for a simple adventure game. Second, we read the scripts out loud. Last, we discuss how the games might be implemented on the computer, and we try to come up with enhancements to make the games more exciting.

One of the most popular parts of my presentation deals with computer-controlled robots. Kids love them! A lot of articles have recently appeared in kids' periodicals about young inventors who are building robots in their folks' basement workshops, in their bedrooms, even in their apartment-house kitchens.

At the beginning of the discussion, I

Instead of little people running about, the computer is powered by tiny bursts of electricity zipping about at a fantastic speed.

make up an imaginary robot whom I call *Humphrey.* Humphrey looks like a cross between a lawn mower and a garbage disposal, but he's a lot smarter: he can beat me at backgammon and chess, he's great at bluffing, and he has an endless repertoire of wisecracks and one-liners.

What's more, he's pretty silly. And using Humphrey's silliness to lighten the discussion, I introduce several basic computer concepts and techniques, including *programs, bugs, loops* and *recursion.* For example, I turn to the page in the book where the Bug lassoes Katie and the Colonel's yellow airplane with his sticky bubblegum rope. Katie and the Colonel hang on for dear life as the monster swings their little plane round and round in a loop, "like a merry-go-round gone crazy."

I tell the kids about bugs and loops in real computer programs, then I describe a short *LOGO Turtle* program:*

```
TO LOOP :SIDE :ANGLE

10 FORWARD :SIDE
20 RIGHT :ANGLE
30 LOOP :SIDE :ANGLE

END
```

Together, the kids and I work through the program and "discover" that it makes Humphrey go around in a circle (or loop). We talk about how the program works and about loops and recursion. Then I play the part of Humphrey executing the program — with input values of 10 centimeters for SIDE and 15 degrees for ANGLE. I goose-step swiftly through one loop, then another, and another, and another. After awhile I become so dizzy and uncoordinated that I collapse in a heap in front of the giggling teachers and kids.

Again at Victory Village Day Care. Here Katie and the Colonel fly a little yellow airplane to RAM Tower to meet the Flower Painters. Unknown to either one, the mean and tricky program Bug lurks around the corner. (Photo by Chip Hoover.)

In talking about programming, I like to touch on the computer's literal-mindedness: How a computer only does what you tell it — nothing more and nothing less. How you may not know exactly what you told it. And how this produces results that are sometimes humorous, sometimes alarming, but always unpredictable.

I talk about bugs and how they creep into programs unexpectedly. I illustrate this problem with another performance from Humphrey. This time Humphrey's mischievous young inventor programs him to play a prank on his big sister. Humphrey is to go barging through the bathroom door, unannounced and uninvited, and surprise the kid's big sister in the middle of her bubble bath.

Unfortunately for the kid (and his big sister), there is a bug in Humphrey's program. The kid told Humphrey to do only one thing: go FORWARD :SIDE. But he set SIDE equal to four meters, and it is only 3½ meters to the bath tub. Humphrey enters the bathroom. Accompanied by horrified shrieks from big sister, he paces forward four meters, bangs into the tub, and does a front flip, landing on big sister's lap and burying himself in pink bubbles.

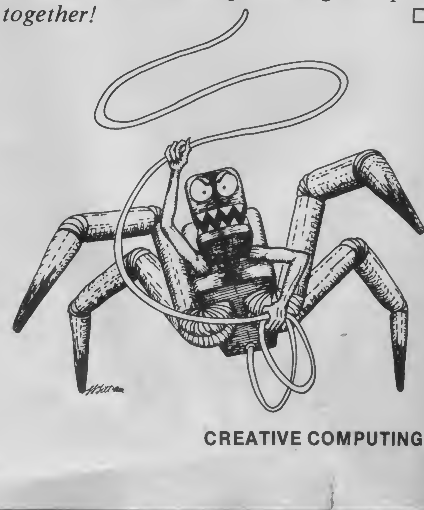
I had little worry about some gullible kid trying to mimic Katie and jump inside a real computer.

I'm not sure the teachers appreciate this example, but the kids love it. It always provokes an animated discussion about robots, programs, bugs and big sisters in bathtubs.

Springboard To The Future

Katie and the Computer is a picture-book adventure that acts as a powerful aid in introducing computers to young people of widely varying ages. The book's color, action and exciting story have served to stimulate children's interest and imagination, making the factual discussion following the story lively and productive.

Admittedly, the story is a fantasy based on magic. But consider the remarkable fantasies children are already spinning on small computers. Consider, too, the fabulous pace at which computer technology is advancing. In this light, *Katie and the Computer* can be seen as a springboard to a *real* future that is waiting only for kids and small computers to grow up — *together!* □



*This example was inspired by *Turtle* robot "Micro-World" programs. The programs, written in LOGO, were found in Ellen C. Hildreth, "The Creation of Design: An Exploration in Art, Mathematics, and Creativity," Cambridge, Mass.: LOGO Project, September 1977.